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NOTES AND COMMENTS.

The Foundryman as an Engineer.

Much has been said and written during recent years anent the somewhat poor regard in which the trade of the founder is held, both in engineering circles and also by the public generally. It has been claimed, and not without grounds, that the qualifications required for the proper conduct of a foundry's operations, if possessed by one working at any other branch of engineering, would be accorded a status of dignity and respect; but when directed merely to the production of good castings, those qualifications are neither acknowledged nor held in high esteem. It is not our purpose to review at the moment the factors and conditions which have conduced to the present position, but rather to suggest one means by which a straight and definite claim might be made for a better acknowledgment of the importance of the founder in industrial life.

It is fairly well appreciated that the title of engineer carries a subtle suggestion of capability, and has an important though indefinite significance in the public mind. An "engineer" is essentially a man of capacity—one who can do things and who is more than a mere tradesman or worker with tools; and hence he must be accorded some respect and dignity. This, in brief, is the general attitude, and so great a hold has the title got, that few even of those who are in engineering circles trouble to ascertain its significance or the qualification of those who assume the title. For this reason it may be well to examine more closely this wide and oft-misused term. It appears to be applied indiscriminately to the man who tends a small donkey engine, and the one who designs a complete steam-power plant and supervises its construction; to the fitter at the bench and the man who constructs a machine for a special operation; to the man who repairs the drains and water pipes and the one who designs and supervises a complete sanitary or water-supply system; to the electric-light fitter, and the constructor and designer of dynamos. Obviously a term with such a wide application can have no true significance unless carefully qualified; and accordingly we find certain broad definitions, distinctions and qualifications adopted. Thus there are generally recognised the three broad divisions of Civil Engineering, Mechanical Engineering, and Electrical Engineering. The work of the civil engineer is very wide, and, in the words of Thomas Tredgold, consists in directing the great sources of power in Nature for the use and convenience of man. He is distinct from the mechanical engineer in that he deals mainly with statics while the latter deals with kinetics. The civil engineer finds his activities in bridge and other structural work, harbour construction, river and canal improvements, and the general control, direction and utilisation of natural resources. The mechanical engineer is more or less confined to engines and machines. The electrical engineer is distinct in that he is concerned with the one force electricity and

its production and utilisation (including, of course, the apparatus therefore); though the man who harnesses waterfalls for the generation of electrical power would more properly be classed as a civil engineer. The mining engineer, though strictly operating at a branch of civil engineering, has work so peculiar and distinct in its characteristics as to call for a separate classification, and this is generally accorded. But our purpose at the moment is not to define the various classes of engineering (the numerous sub-divisions under the above headings each constitute distinct professions), but rather to ascertain what are the essential qualifications of an engineer. According to its derivation the term implies "ingenuity," or the ability to conceive and construct; and that is still the real essential characteristic of a true engineer. Consequently, the host of operatives, whether they be machine minders, makers of mechanical apparatus to specification, or other operatives carrying out the instructions of engineers, have no true claim to the title unless they possess that essential capacity of ingenuity. It must, of course, be acknowledged that an ingenious mind alone, without education, instruction and experience does not make an engineer. In fact, we cannot do better than quote the definition of one writer, which is as follows:—Ability + Education + Training + Experience = Engineer.

Having now obtained some idea of the qualities which entitle one to the description "engineer," we may enquire as to how far these qualifications are possessed and exercised by the competent foundryman in the course of his work. At the commencement we may state at once that all who are simply specialists at some particular branch of foundry work can only claim their special titles as moulders, cupola or furnacemen, core makers, etc. But there are others who form a distinct class by reason of the fact that they possess the ability, education and experience to design the apparatus for, arrange the processes for, decide upon the most suitable materials for, and conduct the whole of the operations for the production of any casting. These qualifications, it is true, are not by any means possessed by all foundrymen, even managers of foundries, but they are characteristic of many who are simply covered by the general term "foundrymen." Now we are not desirous of casting any reflection upon a title which is both ancient and honourable, and possesses a history of which any craft might be proud; but we do claim that a distinction is required in order to differentiate the man of capacity and the operative of little initiative. In mechanical engineering, for example, the reflected glory of the trained and capable engineer is assumed by the simple operative; but in the foundry the grime of the rougher and more laborious operations serves to obscure the value and capabilities of the competent foundryman. Inasmuch as the latter has to exercise a very considerable amount of that ability, ingenuity, and initiative which is characteristic of the true engineer, we may fairly claim that he is entitled to the description "engineer." Is it not time then, that our training schools and colleges acknowledged this fact by establishing a degree descriptive in title of the qualifications in question. The term "foundry engineer," unfortunately, has already been applied to mechanical engineers who specialise in machinery for foundry operations and the lay-out of foundries; otherwise that might have been used to designate the competent foundryman. But as regards college degrees, why not "Batchelor, Master, etc., of Crafts in Founding," or some similar degree, that would at once convey the idea of a definite qualification. Failing that, we would again offer the suggestion that the British Foundrymen's Association institute a special membership, with examination or other qualification, which would imply the same capabilities. We have in mind another association similarly constituted which has successfully instituted a "certificated membership," the certificate being at least some guarantee of qualification for a position of importance and responsibility. Such a membership would not only serve to impress a more correct idea of the importance of foundry work, but would be a goal at which the apprentice and young foundryman could aim. The certified "engineer-founder"—to suggest a title—would essentially be a man of fairly wide qualifications; he would require to have a good knowledge of metallurgy and casting design, the strengths of metals and their applications, pattern design and practice, moulding and core-making methods and appliances, all foundry appliances and machinery, the construction and operation of furnaces, the heat-treatment of castings, systems of shop control and organisation, cost-keeping, and various other matters. He would have to possess the ability to handle a new class of work and display initiative under difficulties. These and many other qualifications are possessed by many men who are now simply classed as "foundrymen," a term which to the uninitiated is significant of little that is either pleasant or dignified. True, there is occurring a marked change of attitude in the engineering world to the foundry department; but why not hasten that change if possible, and particularly as regards the general public, so that the foundry may get a better proportion of the intelligent youths it requires to maintain its status?

The Production of Porous Metals.

We have in previous issues referred to the process invented by Mr. H. I. Hannover, director of the Polytechnic School of Copenhagen, for the production of porous metals. As is well known, alloys of two metals during their cooling will all at once solidify at a determined temperature when they have the eutectic composition. But the eutectic composition occurs only in exceptional cases. Every time that the proportion of one of the two components is stronger, that component begins to be deposited at a temperature higher than the preceding temperature, and the solution becomes impoverished until it attains the eutectic composition. Between the eutectic temperature and the temperature of complete fusion, in the Hannover process, by centrifugal action against a resisting but permeable wall (a metallic mixture, for instance), the greater portion of the fused matter can be removed from a cast plate. There remains therefore in the apparatus a solid matter formed by an interlaced mass of crystals. It has the appearance of a metal, but, under the microscope, its texture and the hollows left by the expulsion of the fused metal are recognised. By mechanical ribbing or perforating, the surface of a sheet of lead may be increased tenfold; but it is a difficult operation. By the use of porous metals, this development is accomplished without difficulty in the ratio of 1 to 130, thus obtaining accumulator plates of a great capacity without having recourse to inclusions of oxides which are apt to get loose. By a modified process, fusible metals may be prepared in the porous state by the aid of electrolysis. The pores are filled in the porous plate with copper or with silver. The lead is then removed by centrifugal force at a temperature a little above its fusion point, and there remains a sponge of copper or of silver.

The Working of Cupolas.

By Joseph G. Horner.

The cupola is one of the simplest of furnaces, yet it has been the subject of much experimental work, and the variations in its design are numerous. There are well-marked national differences also between the standard British, German, and American designs, though of late years cosmopolitan relations have resulted in a considerable imitation and blending of designs in all countries.

All the early cupolas had simple cylindrical shells parallel throughout, rather dwarfed in height, with tuyere pipes bringing the blast directly into the interior, one, two (Figs. 1 and 2) or three separate pipes being used, the number varying with the diameter of the cupola. The bottom was solid, so that the remains of the cast, as coke, metal and slag, had to be withdrawn through an opening at the side on a level with the bottom. Such cupolas were wasteful as well as inconvenient for operation.

The real, successive improvements which have been made, as distinguished from those of a merely experimental character, have been increase in height, the substitution for the individual blast pipes of on air belt or wind chest (Fig. 3) distributing blast through a zone of tuyeres into the cupola, the employment of a second or a third row of tuyeres to supply additional oxygen to the carbonic oxide which is formed above the bottom row, the receiver or forehearth for molten metal (Fig. 4), the hinged drop bottom (in all Figs. but 1 and 2) for the discharge of the day's melting, together with sundry arrangements of minor importance, but which nevertheless contri-

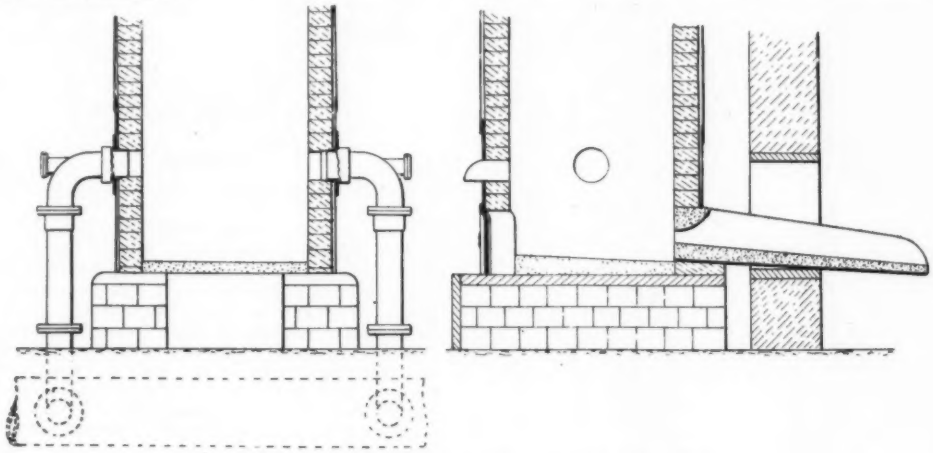


FIG. 1.—OLDER TYPE OF CUPOLA WITHOUT AIR BELT.

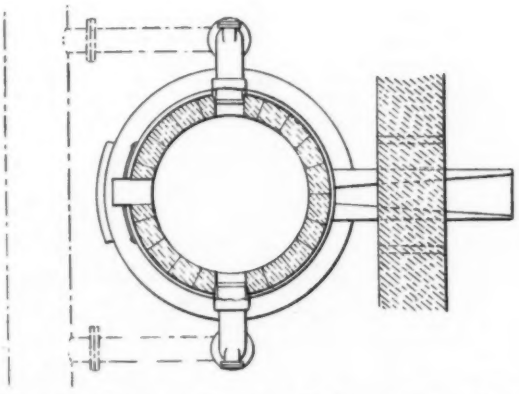


FIG. 2.—SECTIONAL PLAN OF CUPOLA WITHOUT AIR BELT.

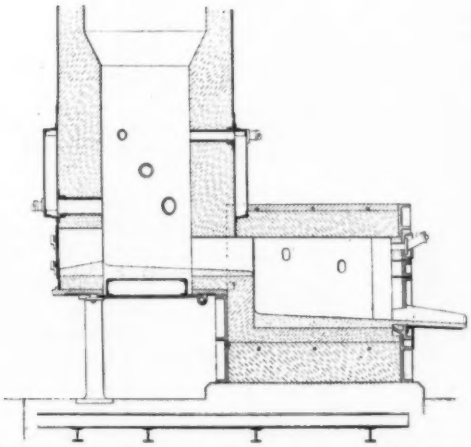


FIG. 4.—CUPOLA WITH RECEIVER AND SPECIAL ARRANGEMENT OF TUYERES.

bute to the efficiency, the economy or the durability, or facilitate the working of the furnace.

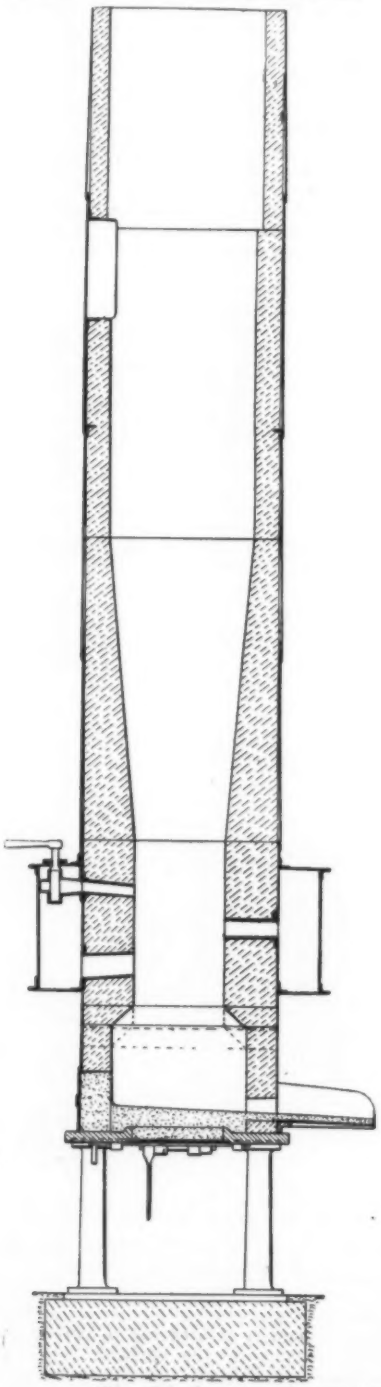


FIG. 3.—CUPOLA WITHOUT RECEIVER (THWAITES BROS., LIMITED, BRADFORD).

The remote origin of most of these improvements is not easily traced, neither would there be much advantage in doing so. Among the hundreds of patents which have been taken out for cupola furnaces one observes the frequent recurrence of similar proposals, so that with few exceptions the cupolas used to-day owe their principal characteristics not to one or two inventors, but to many working at different periods. Especially is this the case with the tuyere arrangements.

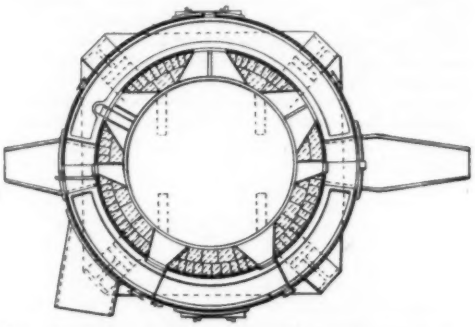


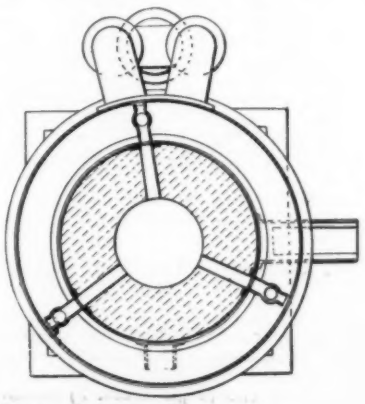
FIG. 5.—FLARING TUYERES OF WHITING CUPOLAS.

Cupola Height.

The height of cupolas is greater in British and American practice than it was before the introduction of the Ireland type. At once that effected great economies in fuel, by preventing the escape of excessive volumes of flame from the charging door and from the top, which occurred in the relatively low designs of furnaces that were previously in service, and which are still retained in some non-progressive foundries. The objection to low cupolas is that unburnt gases, ascending above the melting zone, ignite on meeting with the oxygen of the atmosphere at the charging door and at the top, and so burn to waste, besides subjecting the furnaceman to insufferable heat. A tall cupola affords more space in which complete combustion is able to take place.

Supplying Oxygen in the Right Place

But height alone is not sufficient; it must be accompanied with provision for the supply of enough oxygen in the right place. The object to be kept in view is to supply and utilize enough oxygen to consume as much of the carbon in the fuel as possible within the melting zone, which zone terminates a couple of feet or more below the charging



door. That is the ideal, though its full realization is impracticable.

The key to its realization is the supply of the proper volume of blast at the right localities, and at the pressures which are best suited to the conditions which exist in a cupola at a given time. As these conditions are variable, it follows that the best possible working of a cupola can be achieved only by a constant study and wide experience of those conditions, which vary with variations in the charges from the beginning to the termination of the melting and running down, with the size of the cupola and the proportional areas of the tuyere holes, to

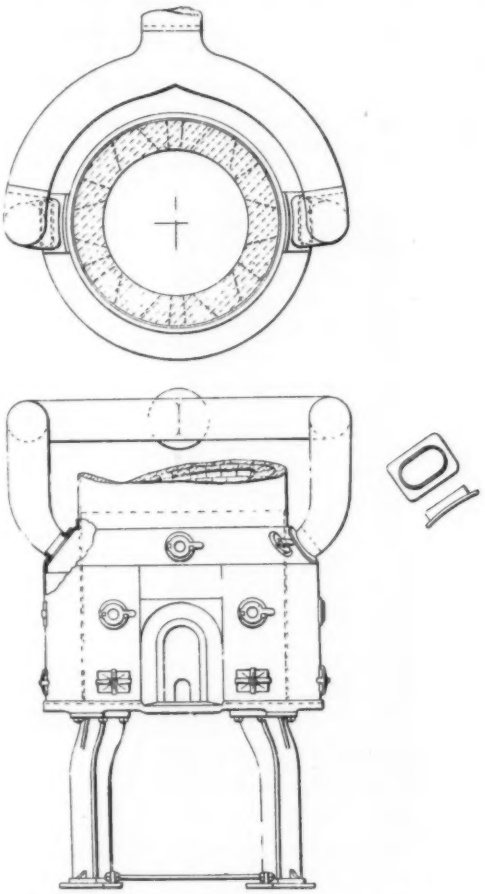


FIG. 6.—BLAST-PIPE ARRANGEMENT OF COLLIAU CUPOLA.

which the volume of blast has to be adjusted continually.

Averages only can be given for any cupolas; the variations must be studied and humoured by the furnaceman, who, fortunately, possesses unerring indications of the manner in which his furnace is working. These are the presence of flame too high up in the cupola, the bunging up or closing of the tuyeres with slag, the formation of scaffolding in the vicinity of the tuyere zone, sluggish cold metal, and slag in excess. All these enable him to understand how to regulate the volume of blast. And here the advantage, though not the absolute necessity, of possessing more than one row of tuyeres, preferably capable of regulation, is apparent.

Efficient Combustion.

The difference which a larger or lesser quantity of oxygen supplied to the fuel makes in the efficiency

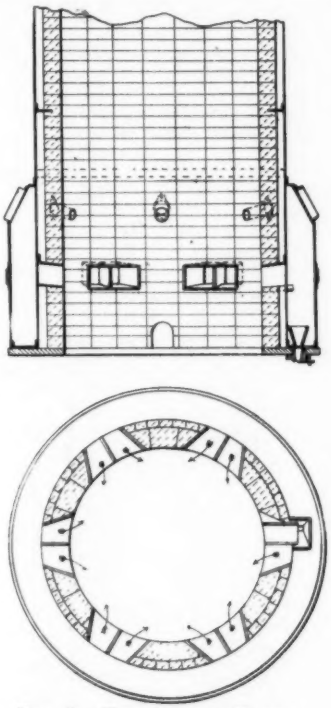


FIG. 7.—THE COLLIAU CUPOLA.

of a cupola is that due to the difference between burning to carbonic acid (CO_2) or to carbonic oxide (CO). The perfect combustion of carbon to CO_2, evolves 14,647 British thermal units per pound of fuel. When only partially burned, to CO, only 4,415

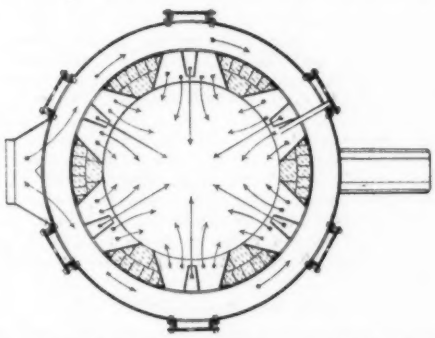


FIG. 9.—DIFFERENTIAL TUYERES IN THE NEWTEN CUPOLAS.

British thermal units are developed from each pound of carbon. A pound of carbon requires 1.33 pounds of oxygen in burning to CO, and 2.66 pounds in burning to CO_2. Therefore if the air supply is insufficient the first oxide only is formed. This means that more

than two thirds of the possible heat units are lost at the top of the cupola. Even in the highest melting ratios which are obtained in practice there is a large amount of waste as compared with the theoretical values. Though the gases may be almost thoroughly burnt, there is much loss in warming up the inert nitrogen, in warming the blast, in radiation, and in unavoidable heat losses in the iron and in the

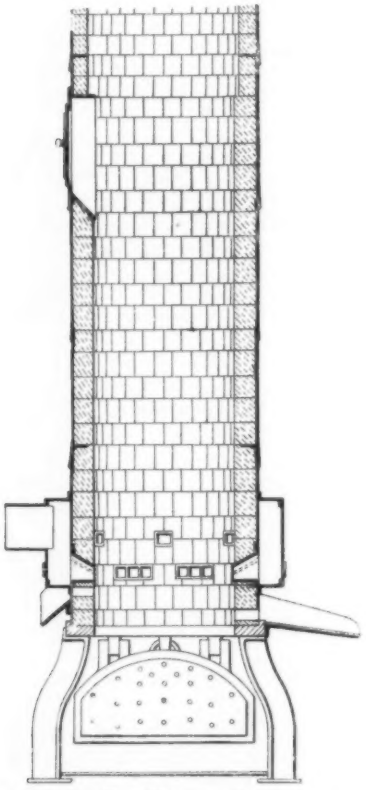


FIG. 8.—THE NEWTEN CUPOLA.

chimney. Theoretically between forty and fifty pounds of iron should be melted by one pound of coke. If iron melts at 2,200 deg. Fah. and goes into the cupola at 60 Fah. its temperature has to be raised 2,200−60=2,140 deg. The specific heat of cast iron is 0.12983. Hence $2.140 \times 0.12983 = 277.836$ total heat units. Dividing 14.647 by 277.836=53 pounds. Coke is not pure carbon. If it contains 94 per cent. of carbon, which is a good coke, the amount of iron which could, theoretically, be melted by one pound of it would be $53 \times 0.94 = 49.8$ pounds, a ratio of about 50 to 1. Actually, a ratio of 10 to 1 is very good; 8 to 1 is good; 6 or 7 to 1 represents satisfactory practice.

The Use of Air Belts.

The air belt here offers advantages over the single tuyere pipes because it permits of better regulation of the blast and additional oxygen supply. Many cupolas having single tuyere pipes were formerly made with an upper as well as a lower row of tuyeres. The method is still retained in a modified design in the Greiner & Erpf cupola, in which a series of single tuyeres discharge blast at several different heights above, and in addition to, the supply sent directly through the air belt. The economy of this cupola is high, and it is used to a considerable extent in Great Britain as well as in Germany.

The air belt is an old invention, the appreciation of which has been more rapid in America and in Germany than in England, though comparatively few cupolas are now built in Britain without a belt. Its advantages are that it permits of a better distribution of the blast than the single-tuyere pipes do, and tends to lessen the risk of bunging up, or scaffolding. The blast, which in the tuyere-pipe system enters through two large openings, if carried into a belt is distributed through, say, half a dozen openings if a single zone of tuyeres is fitted, or through a dozen in the case of two zones of openings. The chilling effect is also correspondingly lessened. The cutting effect of the reduced openings is avoided in several designs by enlarging or flaring the openings into the interior of the furnace, so spreading and softening the blast (Figs. 5, 7, 9).

The upper row or rows of tuyeres are usually made capable of regulation so that they can be shut off entirely, or only partially closed. These are the

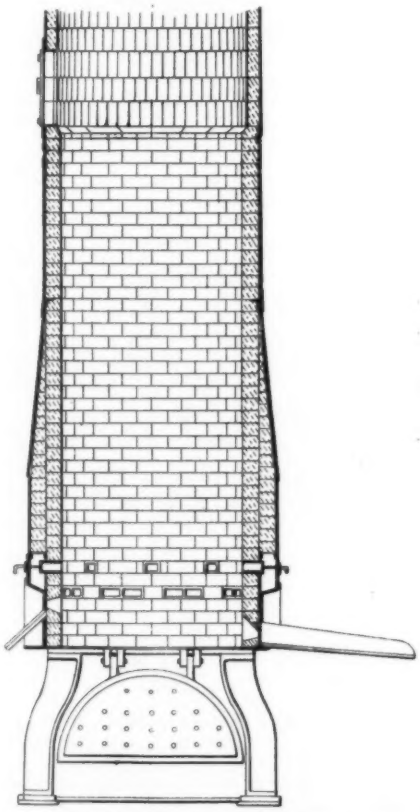


FIG. 10.—THE CALUMET CUPOLA.

tuyere arrangements which are now embodied in the best cupolas in all countries. The remarkable success of this design is due to the thoroughness with which theory has been translated into practice. It is based on the fact that there is no free oxygen above the tuyeres. Hence when the blast enters, its oxygen combines with the carbon in the fuel to form CO_2. This in its ascent through the coke unites with another

atom of carbon and forms CO. This again demands oxygen for its conversion into CO_2, with development of intense heat of combustion. In other words, the conversion of as much as possible of the carbon in the fuel into CO_2 within the melting zone is the object sought in order to develop all the heat units possible. The arrangement of supplementary tuyeres,

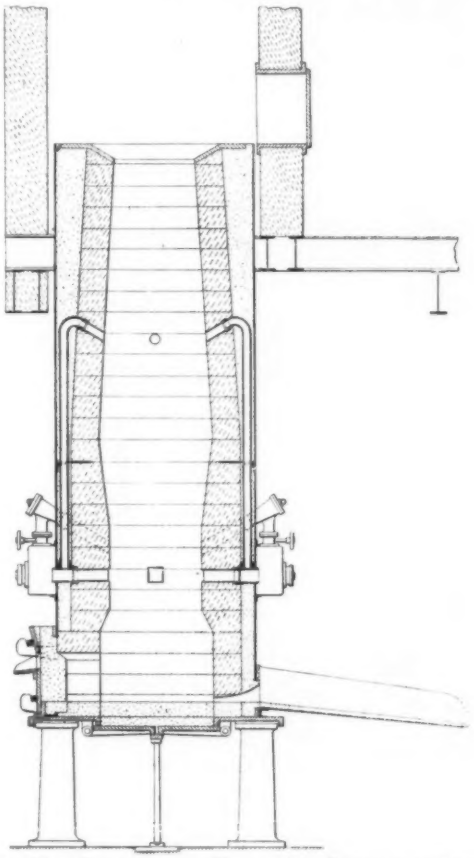


FIG. 11.—CUPOLA WITH UPPER AIR BELTS FOR COMPLETE COMBUSTION OF CARBONIC OXIDE. (THE LAISSLE FOUNDRY AND MACHINE WORKS, REUTLINGEN, GERMANY.)

of which there are usually half a dozen, supplies air in small volumes to the CO formed in the melting zone.

Using Several Rows of Tuyeres.

In arranging rows of tuyeres the openings must not be placed directly one over the other, but should "hit and miss" (Fig. 4), so forming alternate currents of blast instead of introducing cold air on metal already fused or fusing. The hottest part of the fire is not opposite the tuyeres, but a few inches higher, perhaps 9 inches to 12 inches. To bring in cold blast against the fusing metal exercises a chilling influence for a few inches inwards and tends to bunging up of the tuyeres with slag, and to wear of the lining. A result is the raising of the melting zone above the upper tuyeres, with a corresponding deepening of the bed and a larger consumption of fuel.

Hence, in arranging rows of tuyeres, diffusion, and not concentration of blast must be accomplished, and to secure this the openings should not be arranged perpendicularly, nor be very far apart vertically. If they supply a uniform and sufficient quantity of air to the melting zone, which can be judged by the working of the cupola in economy of time and of hot metal, though not necessarily in fuel consumption, their real efficiency is demonstrated. This explains why an upper row of badly-arranged tuyeres has frequently been abandoned; also why the amount of opening of the upper row is frequently made capable of regulation to suit different conditions of melting; and why the area of the upper row or rows is less than that of the lowest row by one half or less, because of the chilling influence of a large body of cold air on metal which is undergoing fusion.

The Newten cupola made by the Northern Engineering Works of Detroit, Mich., has its lower tuyeres fitted with a differential device, Figs. 8 and 9, which sends a portion of the blast right to the centre, while the larger volume is diffused more softly about the other parts of the cupola. The tuyeres are of the enlarged form, giving nearly a continuous circle of blast; but near the centre of each, two plates are set to converge, enclosing the shape of a truncated cone through which the blast, being contracted, is forced to the centre of the cupola. The

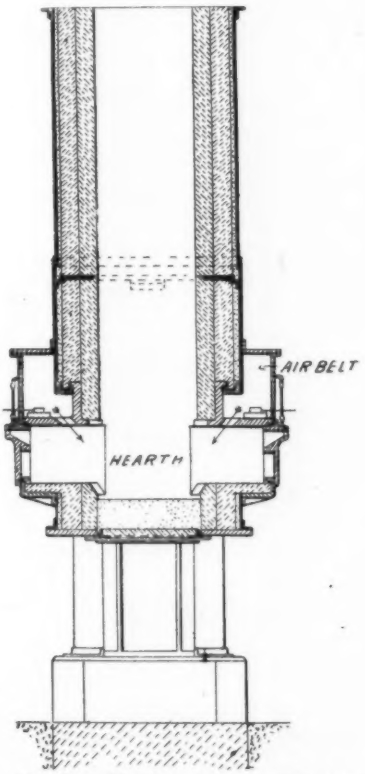


FIG. 12.—THE KRIEGER CUPOLA WITH AIR-BELT ABOVE ENLARGED HEARTH.

remainder of the blast is diffused more softly to right and left. In Fig. 13, the blast is directed tangentially.

In some cupolas the principal peculiarity is that the air belt lies snugly within the shell instead of being located outside of it; that is, the lower portion of the shell is parallel outside, and the bricks are

carried inwards at the zone of the tuyeres, forming boshes, leaving room for the air belt. This affords the additional advantage that the area required for the bed charge is correspondingly reduced, with an economy of fuel of about one third over the parallel design of shaft; that the blast gets right to the centre; and that the slag drops clear of the bottom row of tuyeres without risk of bunging them up. As an excessive pressure of air blast is undesirable, and as upper portion of the furnace. Frequently, then, in order to allow sufficient capacity to contain a large volume of metal, the hearth below the tuyeres is enlarged to the same diameter as the upper section of the furnace (Figs. 11 and 12).

The Economy of a Fore-Hearth.

The receiver or fore-hearth (Fig. 4) is more common in British and German designs than in American.

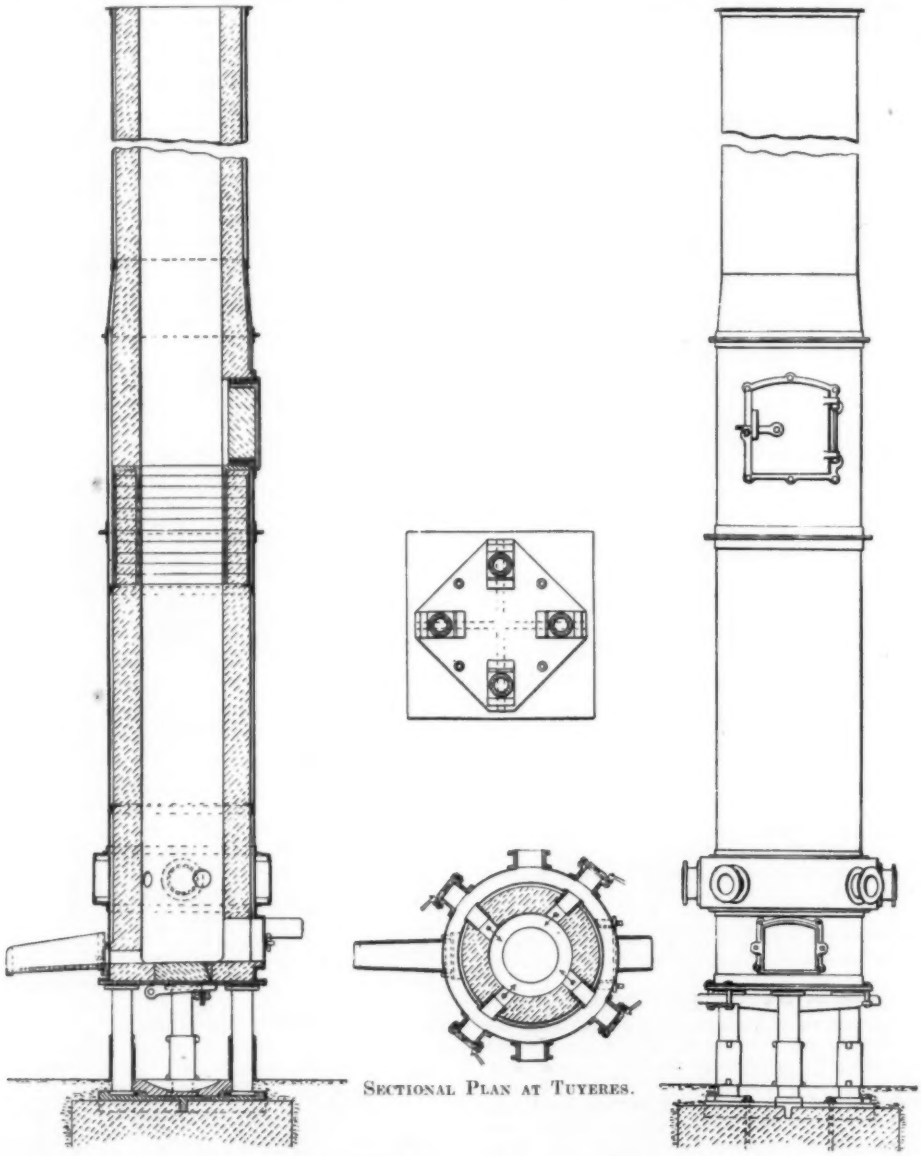


Fig. 13.—Cupola with Tangential Tuyeres (London Emery Works Company.)

the blast must penetrate to the centre of a cupola, it is necessary in all large furnaces to contract the diameter at the tuyere area. This involves making the interior with sloping boshes through a portion of the melting zone, to meet the large diameter of the

It is better than having a separate receiver to take the metal of several tappings which are required for heavy casts, or allowing the metal to collect and stand in two or more separate ladles for massive casting, each of which is alternative and common practice.

The deep bed charge of the ordinary cupola is generally regarded as an expensive and objectionable feature. In a cupola about 2 ft. 6 in. in diameter, about six hundredweights of coke are required for the bed charge, and correspondingly more in those of larger dimensions. A portion of this may be recovered after the bottom is drawn or dropped. All or most of this coke lies below the melting zone and does not contribute to combustion. It is a bed into which the melted iron drops, and on which the slag collects, to be withdrawn at intervals. The iron remaining in contact with the coke is liable to take up sulphur from it. When tapping is done, the column of metal, some of it imperfectly melted, and the coke above sink down to the hearth below the zone of fusion, and the iron tapped out is not perfectly hot nor soft. These evils and risks are avoided by locating an independent receiver or fore-hearth at the side of the cupola. A smaller bed charge is required, being only from one third to one half of that for the deep hearth. The iron as it melts flows into the receiver, together with the slag. The latter is tapped out at intervals. The melting is regular, the iron is removed from contact with the fuel, and does not become chilled.

The fore-hearth built against the cupola receives the metal as fast as it melts, and holds about as much as would melt in half an hour, retaining its heat until the moment of pouring. The metal mixes better in a receiver than in the cupola among the fuel, and slag is less liable to be entangled in it than in the furnace. The slag is drawn off from the surface of the metal in the receiver better than from the hearth; and a much smaller bed charge of coke is required when a receiver is used than when it is not, approximately only one third the amount. The latter is an item of considerable importance, though more so in light, short meltings than in those which are heavy and prolonged.

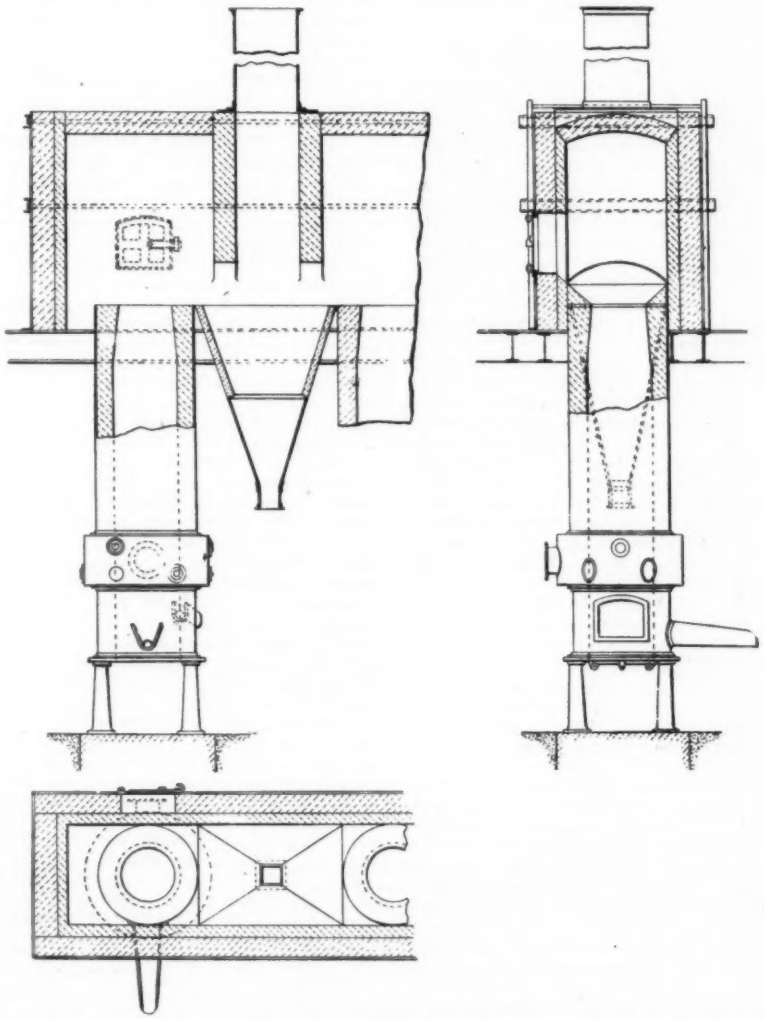


FIG. 14.—TWO CUPOLAS DISCHARGING INTO A COMMON SPARK CHAMBER. (THE BADEN ENGINEERING WORKS, DURLACH.)

The Hinged Drop Bottom.

This, though not in any way related to the efficiency of a cupola, is much to be preferred to the older solid bottom. The hinged door, on being released by a latch, allows all the contents to fall out at once. With a solid bottom they have to be raked out at the side, an operation which takes ten or fifteen minutes, and is very hot work. It is necessary also to melt all the superfluous metal, or that left over from casting, in order to run it out from a solid bottom, while it can be discharged from a drop bottom unmelted or partly melted, along with the partly-burn coke and the slag. If water is thrown over it, the constituents can be separated and used again the next day.

In the Calumet cupola, an American design, the air belt is enclosed within the shell (Fig. 10). That is, the parallel shaft is enlarged on the outside about the melting zone and down to the base by an additional layer of bricks above the air belt, which are built on the upper part of the air chamber. This leaves the bottom of the cupola open to inspection from below; its baseplate being mounted on legs, clears the drop doors. Also the inner tuyere plate can be renewed if it burns out. The cupola is also very stable, due to the spreading base.

The tuyeres are arranged in two rows with openings enlarging into the interior. The upper row is fitted with dampers, to be closed if necessary. There is a safety tuyere to convey away any metal which might overflow into the belt.

In the Laissle cupola, Fig. 11, made by the Laissle Maschinenfabrik und Giesserei, G.m.b.H., of Reutlingen, Germany, there are three rows of tuyeres, the upper row supplying air above the melting zone, where its effect is to increase the temperature of the charges as they descend. The pipes which convey the air to these upper outlets are buried in sand, which lies between the shell and the lining. The tuyeres which lie above the bottom row are set at an angle, so as to direct the discharge downwards on to the metal which is in a molten state. The top of the cupola has a chimney surrounding it, forming a spark catching chamber. In Fig. 14, two cupolas discharge into a common chamber.

Melting Ratios.

Various miscellaneous arrangements of relatively minor importance contribute to the economy or durability, or facilitate the working of the cupola. The ultimate object is to melt as much metal as possible with the smallest expenditure of fuel, consistent, of course, with thorough melting. A certain quantity of metal, say a ton, is melted by so many hundredweights of coke, say two, three, or four. The first divided by the last gives the "melting ratio," a quantity around which foundry managers are in rivalry, and concerning which no statement can be made of more than very general application.

The melting ratio must obviously vary within wide limits, because it is subject to so many conditions. Hence comparisons and statements can be of real value only if they are made under identical circumstances. Sometimes the ratio is stated without including the amount of coke in the bed charge, which if included in the case of a melting of short duration might reduce the ratio by nearly or quite one half. In a prolonged melting, running down a large quantity of metal, the bed charge will form but an insignificant proportion to the whole. Again, in casting light work, the metal must necessarily be hotter, that is, more thoroughly melted, than for very massive work, and this requires a larger proportion of fuel. Pure, clean pig-iron and scrap will require less fuel to melt it than dirty inferior scrap with much slag will want. But even observing these differences, and including the bed charge, in all comparisons there is much difference in cupola performances, greatly to the disadvantage of the older types.

In the better designs of cupolas, as built now, there are probably not very material differences if they could be tested and compared under identical conditions. Successful cupola practice cannot easily be reduced to set written rules. So many factors enter into the question—blast supply and regulation, quality of metal and quality of coke, besides those which have just been stated. From the commencement to the termination of the day's work constant watch has to be maintained through the peep holes on the quality of the slag and the condition of the metal, on the flame at the charging door and on the blast gauge, and each has to be regulated, altered, corrected from hour to hour as well as from day to day.

Foundrymen's Visit to Bournville.

The Birmingham Branch of the British Foundrymen's Association made a new departure in the matter of visits on July 26, the afternoon being spent in a tour of the model village and recreation grounds at Bournville, founded by Mr. Geo. Cadbury. Over seventy members and their freinds (including ladies) accepted the invitation.

The ten days annual holiday of Cadbury's employés having commenced that day, both the recreation grounds and the village were almost deserted, about 600 of the workpeople having departed, either to the seaside or to the country.

The girls' pavilion, which was first visited, is spacious and well equipped, and the gardens are charmingly laid out. Nothing could be more refreshing than the wealth of foliage and the variety of bloom everywhere to be seen. Passing through the well-stocked old English garden, an inspection was made of the alms-houses, for the foundling of which the late Mr. Richard Cadbury was responsible. Of these, there are 43 inmates, only four, however, being former employés of Messrs. Cadbury, though these, or their widows, have first consideration among candidates for admission. Inmates must be sixty years of age, and single persons must be in receipt of at least 5s. per week, married couples 7s. 6d. per week. Continuing the tour, the visitors inspected the childrens' playground, provided for the sole use of children, and furnished with swings, toys, etc., and "The Beeches," a children's holiday home for the use, in summer, of 24 Birmingham slum children and twelve Salvation Army officers, and in winter as a rest home for such officers. The houses, of which there are 933 built, or in course of erection, are all semi-detached, and each has sixty yards of garden attached. The houses are 20 ft. from the road, and as the roads are 42 ft. wide, this secures a distance of 82 ft. from house front to house front. The present population is 4,400. The special buildings include a school costing £33,400, presented by Mr. Geo. Cadbury, a meeting house, a Ruskin hall for art classes, and swimming baths for men and women.

At the close of the tour, the visitors were entertained to tea.

After tea, Mr. R. Buchanan proposed a hearty vote of thanks to the firm and to the guides, who had conducted the parties round the village.

The resolution was carried unanimously.

Mr. Kenneth Chapman, on behalf of Messrs. Cadburys, acknowledged the compliment, remarking that they at Bournville were rather proud of the first garden city in the world. It had its origin in one man—and in one man only—namely, Mr. George Cadbury.

The Primary Heat Treatment of Cast-Iron.

By David Whitelaw.

The term "heat treatment" as used at present with regard to metals and alloys, refers to any process by which a metal is heated after it has been cast and cooled to ordinary temperatures. The term is thus restricted to what might be called an after-treatment. Now this restriction seems unwise, for surely the processes of melting and casting are modes of heat treatment, and their varying conditions may cause the greatest irregularities in the properties of the metal or alloy. Any term, however, would be useless, because of its vagueness, if it were made wide enough to include all the processes which require the application of heat to a metal or alloy. Two new terms seem, therefore, to be required with reference to heat treatment, and the terms now proposed are "primary" and "secondary." The term "primary heat treatment," is applied collectively to those conditions brought about by the melting, casting, solidification, and the cooling subsequent to the solidification of a metal or alloy. The term "secondary heat treatment," is the class name for those conditions set up by the re-heating and annealing, or the re-heating and quenching at a given temperature, or any other heat treatment to which a metal or alloy may be subjected after it has been cast and cooled to ordinary temperatures. Perhaps a third term is also needed so that the smelting conditions may also be classified. If this be so, these conditions would naturally receive the term primary, and the two sets of conditions already spoken of would be called respectively the secondary and the tertiary heat treatment. At this point, however, the need for only two new terms will be assumed, and what will therefore be called "the primary heat treatment of cast iron" will now be considered.

From a practical point of view, the application of chemistry to iron founding is beset with no greater difficulties than those presented by the control of the primary heat treatment. Up to the present time, these difficulties have received but little attention. The difficulties are of two kinds; those arising from our imperfect knowledge of the facts and of their explanation, and practical difficulties presented by the control of working conditions. Successful practice, of course, requires correct theory, and so the facts and their explanation must be considered first. Now since all points are of equal importance, and since the various questions are so correlated that the discussion of one involves the discussion of all, a beginning may be made with the question of casting temperature.

Upon this question a most unqualified assertion has been made in these words ". . . it has now been clearly demonstrated, that the higher the casting temperature the more combined carbon is there likely to be in the final casting . . . . " Now, undoubtedly, there are conditions under which a high combined carbon will result from a high casting temperature: but that these conditions are not universal, to say the least, will now be shown. A small jacketed cylinder weighing about 25 cwts., was cast with metal which proved to be too hard to be machined. When the casting was broken up, the bottom parts of the jacket were found to be grey, while the top parts were chilled. The chilling grew in depth from the middle parts upwards, until at the top the metal was white throughout Now the jacket was run through the bottom, the metal being poured down the barrel; that is to say, the metal which finally reached the top passed first through the bottom. In its passage the metal must have given up some of its heat to the bottom parts of the mould, and thus when it reached the top parts, the metal must have been at a lower temperature than that which the bottom parts of the mould finally received. In other words, the top parts of the jacket were cast at a lower temperature than the bottom parts. Here then, was a case in which the combined carbon was increased by lowering the casting temperature.

A result opposite to that just described, was obtained in the case of three chill blocks, which were all cast from the same ladle but at different times. The one cast first had about $\frac{5}{8}$ in. of a chill, the second about $\frac{1}{2}$ in., while the third had only a trace of a chill. By the time the third block was cast the metal was almost too pasty to run. The explanation of these opposite results may not be easy, but whether they be explained or not, the results which any given sets of conditions will produce must be known in practice. But how is this to be determined? The question leads to a fuller dealing with the primary heat treatment, in the light of which enquiry the fuller consideration of the question of casting temperature can best be carried on.

There are some conditions the effects of which are undeniable. For instance, there is no question that prolonged cooling reduces the amount of the combined carbon. Any condition, therefore, which affects the rate of cooling is a condition the effect of which we already know and one such condition is the conductivity of the mould. The conductivity will vary with the thickness, the composition and the temperature of the mould. There is an almost universal belief regarding the result brought about by the difference between the composition of a green-sand mould and that of a loam mould. According to this notion a green-sand mould will give a harder casting than a loam mould. Now an exactly opposite result has actually been obtained, and, be it noted, this opposite result was found, although both castings were made with exactly the same metal, and although the weight of the loam casting was fifty times that of the green-sand one, while at many of the hard parts of the loam casting, the sectional area was equal to that of the green-sand casting. From all points of view then, the conditions seemed to favour a result exactly opposite to the one obtained. There is, therefore, no universally applicable rule relating to the conductivity of a loam mould compared with that of a green-sand mould. If a loam mould has thin sections, or if it be very cold, its conductivity will be very great. Its temperature will vary with the heating it receives in the drying stove, and with the time required to close it, and also perhaps with the currents of air to which it may be exposed while it is being closed. There are thus a number of variable conditions which make general statements valueless. Further reference to moulding details need not however be made now, the present object being to point out that the rate of cooling is affected by the conductivity of the mould, and that this in its turn is influenced by a number of varying circumstances. Whether the casting temperature be one of these circumstances must now be considered, and on this point but one conclusion seems possible.

The cooling of a casting must take place by the heat of the metal escaping through the mould. If

the amount of heat which must so pass be increased, then the temperature of the mould will also be increased during the cooling period, and the conductivity of the mould will thus be decreased. Now if the casting temperature be increased the amount of heat which must pass through the mould will also be increased. A high casting temperature will therefore reduce the rate of cooling by reducing the conductivity of the mould. Of course, a high casting temperature will reduce the rate of cooling directly, by increasing the amount of heat which the metal must give up before it solidifies. The indirect effect, however, is the more important one, for by it a reduction in the rate of cooling takes place when such a reduction is of most importance, because of the range of temperatures through which it is brought about.

The rate of cooling through different ranges of temperature will be more fully discussed later. Meanwhile, that the casting temperature may bring about the result just referred to, may be shown by the case of the cylinder already mentioned. No chilling would have taken place in this case, if the casting temperature had been high enough to ensure that before the metal at the top had been brought near to the point of solidification, it had given the top parts of the mould heat sufficient to raise their temperature to that of the bottom parts. In this way, before chilling could have taken place, the conductivity of the top parts of the mould would have been reduced to what was finally the conductivity of the bottom parts, where no chilling took place. But it may be asked: How is the case of the chill blocks to be explained? This question leads to the fuller consideration of the rate of cooling.

Chilling is said to be brought about by rapid cooling. What, however, is meant by "rapid cooling?" The term is plainly indefinite. There is nothing to show that rapid cooling through one range of temperatures will have the same result as rapid cooling through another range of temperatures, and the case of the chill blocks clearly shows that there is a point below which rapid cooling will not produce chilling—a point which may be called the chilling temperature limit. Now in the case of the unchilled block, the casting temperature almost coincided with the chilling temperature limit. The block cast first was chilled most deeply because the higher casting temperature increased the period from the time of pouring until the time when the chilling temperature limit was reached, and in this way allowed the largest body of metal to be rapidly cooled to the chilling temperature limit. The point may be made clearer by illustration. Let A, B, and C represent the three blocks, and let the varying depth of chill be shown by the spaces between the bottoms of the blocks and the lines X, Y, Z.

Now the solidification of a casting begins with the formation of a shell or crust at the points in contact with the mould. At the surface next to the chill plate a chill crust would be formed, and the growth of this

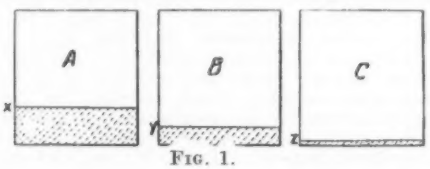


FIG. 1.

crust would stop when the temperature of the metal immediately above the crust fell below the chilling temperature limit. A being cast first, its chill crust would grow to the greatest extent, say, till the line X was reached. In other words, the casting temperature being highest in the case of A, the greatest time elapsed between the time of pouring and the time when the temperature of the metal above the chill crust fell below the chilling temperature limit. B and C being cast at lower temperatures, in their cases the chilling temperature limit would be reached sooner than in A, say, in B, when the chill crust had grown to the line Y; while in the case of C, the chilling temperature limit was reached almost as soon as the casting was poured, so that the chill crust had no time to grow, and the line Z which shows its depth almost coincides with the bottom of the block.

The results obtained in the cylinder may be referred to again, so that their lesson may be read in the light of what has just been said. By the time the metal had reached the top parts of the cylinder mould, its temperature had probably fallen near to the chilling temperature limit. The top parts of the mould being cold, and their conductivity being therefore great, as soon as the already partially cooled metal reached the top, it would be rapidly cooled to the chilling temperature limit. In other words, the top parts of the mould, for the time being, played the part of a chill mould. The chilling could not have occurred if the metal at the top had been as hot as that at the bottom, and if, besides, the temperature of the top parts of the mould had been as great as that of the bottom parts. Now these conditions might have been obtained if the casting temperature had been so high that even when the metal had reached the top it still could have heated the mould considerably without being itself brought near to the chilling temperature limit. As already stated, the conductivity of the mould decreases as the temperature of the mould increases. Now, if the casting temperature be increased, then when the casting is cooling down, the temperature of the mould will also be increased; and if this increase be great, then rapid cooling down to, or near to, the chilling temperature limit will be impossible, the mould being too hot to act as a chill mould as it did in the case at the top parts of the cylinder mould.

The conclusion then seems to be that in those cases where a high combined carbon results from a high casting temperature, the conditions are similar to those of a chill mould; that is to say, the conditions favour a rapid cooling down to, or near to, the chilling temperature limit. In any case, the whole of the conditions must be taken into consideration, and it should be noted that in most cases no definite statement can be made as to the effect of casting temperature alone, for in most cases it is impossible to vary the casting temperature without also varying the conductivity of the mould, and therefore the rate of cooling. It cannot be too strongly emphasised that not one, but all the conditions must be kept in view, and if not controlled, they should as far as possible be allowed for; and here the difficulties of practice present themselves.

Working conditions vary so much that the same metal may give entirely different results when used at different times for castings of exactly the same weight and sectional dimensions. A fixed analysis for any given type of casting is thus impossible. No doubt, approximate analyses may be given, the limits of which would correspond to the probable limits in the variation of the primary heat treatment; but working conditions would have to be very carefully regulated if standard analyses were to be adopted. It is highly important that this fact be fully appreciated by those to whom the specifying of analyses may be entrusted. Indeed, only physical tests for grey cast iron should be specified, and the founder should be left to find out the analyses which best suit his conditions.

Foundry Sands and their Treatment.

By Algernon Lewin Curtis, M.E.

(*Continued from page* 532.)

A Partial Study of Moulding Materials.

Monazite.—A doubly-refracting biaxial mineral, being a phosphate of cerium, lanthanium, and didymium $(CeLa)_2P_2O_8$. Usual appearance in the form of well-rounded grains, on account of softness of the mineral (see Fig. 16). Yellow to pale brown in colour. Index of refraction = 1.796 > methylene iodide. Soluble in HCl. Very refractory and only rarely seen in moulding sands.

Andalusite or Chiastolite, Sillimonite-Kyanite or Disthene.—All these are doubly-refracting biaxial minerals. All are silicates of alumina, andalusite being $Al(AlO)SiO_4$. Usual appearance in short rounded, prismatic crystals, with almost square section. Colourless, or at times pale reddish and spotted. Index of refraction = 1.632 > moniodobenzol, hence relief well marked and surface rough. Cleavage parallel to almost square prism may show. Carbonaceous inclusions are characteristic, arranged as in microscopic specimens (see Chiastolite, Fig. 17). Very characteristic of metamorphic schists and of contact zones of clay slates with granite, etc., but not found in rocks which have been formed under great pressure. May also form parallel growth with sillimanite. Insoluble in HCl. Specific gravity, 3.18. Hardness, 7 to 7.5. Very refractory.

Kyanite or Cyanite Disthene $(AlO)_2SiO_3$.—Anisotropic. Triclinic, usual appearance in blade-like crystals without terminal planes, but with cross-sections (six-sided), showing two long parallel edges and four shorter edges, also in columnal aggregates. Colourless or bluish and spotted (see Fig. 18). Cleavage perfect, appearing as sharp cracks parallel to longest edges in cross-section. Index of refraction high = 1.729 >methylene iodide. Found in gneiss, granulite, metamorphic schists, etc., commonly associated with garnet, not attacked by acids. Specific gravity 3.6, hardness 5 to 7. Very refractory and occasionally found in sands.

Epidotes.—A doubly-refracting group of five biaxial minerals being silicates of lime, alumina and iron, with water in chemical combination. $Ca_2Al_2(AlOH)SiO_4O)_3$, with some Fe replacing Al. Usual appearance columnar to thick tabular crystals, more or less elongated, parallel to ortho axis, or in granular aggregates. Colourless to yellowish if Fe. poor, or yellow to yellow-brown if Fe. rich. Index of refraction = 1.746, nearly >= methylene iodide; hence relief high and surface rough. Cleavage parallel to base, basal cleavage cracks not very numerous, and appear parallel to general direction of elongation. Epidote is essentially a secondary mineral, resulting from the alteration of the felspars and ferro-magnesium silicates. It is found in crystalline schists (especally those containing hornblende), gneiss, gabbro diabase, lime-silicate hornstones, contact rocks, etc. Is partly decomposed by HCl. Specific gravity 3.32 to 3.45. Hardness 6 to 7. Is easily fusible, consequently detrimental to moulding sands, in which it is very common.

Pyroxenes.—A group of nine doubly-refracting biaxial minerals, viz., enstatite or bronzite, hypersthene, diaclasite, diallage, green augite (diopside), augite, aegyrine (acmite), jadiete, triphane. Pyroxenes are sub-divided into two groups, viz., the orthorhombic pyroxenes and monoclinic pyroxenes. Orthorhombic pyroxenes found in moulding sands are chiefly enstatite and hypersthene. Enstatite or bronzite is a silicate of magnesium and iron $(MgFe)SiO_3$. Its usual appearance is in irregularly bounded individuals, a columnar or fibrous structure often showing as in Fig 19. Colourless to yellowish, varying with proportion of Fe. Index of refraction 1.665 to 1.723, high from > α-monobromnaphthalene > to methylene iodide. Variable cleavage being parallel to prism (angle 92 deg.), which is common to all pyroxenes. Hardly any pleochroism can be observed in enstatite. Found in all granular rocks of the gabbro-peridotite series, also in olivine basalts. Not soluble in HCl. Specific gravity 3.1 to 3.5. Hardness 5 to 6. Found in most moulding sands. Possesses a low fusing point. Hypersthene is also a silicate of magnesium and iron, but contains approximately 10 per cent. more Fe. than enstatite. Usually seen as rounded prismatic-pyramidal crystals. Index of refraction 1.682 to 1.705. Brownish in colour. Distinct pleochroism changing from brownish red to greenish, increasing with amount of Fe. Insoluble in HCl. Low fusing point. Hypersthene can be distinguished from enstatite by its optical sign, strong pleochroism, and greater magnetic permeability.

The monoclinic pyroxenes found in moulding sands are usually augite and diopside. Augite is a slicate of lime and magnesia, with an addition of lime and alumina, $RSiO_3$. R=Ca, Mg, Mn, Fe, Al chiefly, with the Ca predominating over the Mg. Appears both as crystals and more or less irregular grains, the character varying with chemical composition; red to brownish red in colour. Index of refraction 1.68 to 1.72 = α-monobromnaphthalene to α-methylene iodide. Relief high and surface rough. For cleavage fragments of augite see Fig. 20. Cleavage cracks distinct and numerous, but not generally running through crystal. Fig. 21 shows augite with good cleavage.

Probably next to quartz and the felspars, the pyroxenes are the most common mineral found in moulding sands produced from igneous rocks. If heated to redness on platinum foil, green and red augites may become red in colour. Insoluble in HCl. Specific gravity 3.3 to 3.5. Hardness 5 to 6. Mechanical separation with pyroxenes is quite possible on account of their higher specific gravity than amphiboles. Low fusing point, therefore not desirable in moulding sands. Diopside is a silicate of lime and magnesia. $Ca(MgFe)Si_2O_6(Al_2O_3)$ occurring in long columnar crystals or grains. Colourless to greenish. Index of refraction about the same as enstatite. Hardly any pleochroism. Insoluble in HCl. Found in contact rocks. Fusing point 1,375 deg. C.

Amphibole.—A doubly-refracting group of ten varieties, viz., anthophyltite, gedrite, tremolite, actinolite, common hornblende, basaltic hornblende, arfvedsonite, barkevicite, glaucoplane or gastaldite riebeckite, the chief of which met with in moulding sands are hornblende, actinolite, and tremolite.

These varieties are silicates of magnesium, iron, aluminium and lime. Tremolite $CaMg_3Si_4O_{12}$, actinolite $Ca(MgFe)_3Si_4O_{12}$. Common hornblende same as actinolite, but containing Al_2O_3. Hornblende usually occurs in more or less irregular grains or crystals (see Fig. 22), its character varying with the chemical composition. Tremolite and actinolite may appear in long columnar to needle-like individuals having no terminal planes or frayed-out ends, or they may be in dense aggregates.

FIG. 16.—MONAZITE. MAG. × 20.
(From Hatch and Rastall).

Tremolite colourless, actinolite green, common hornblende green to brownish Index of refraction variable, 1.621 to 1.641, but generally $\alpha >$ moniodobenzol to methylene iodide; relief distinct and surface rough. Perfect cleavage, generally appears in thin sections as sharp cracks crowded close together (see Fig. 23). Long prisms of actinolite and tremolite may show transverse parting. Iron ores,

FIG. 18.—KYANITE. MAG. × 20.
(From Hatch and Rastall).

apatite, etc., may be found as inclusions in hornblende. The coloured amphiboles all show pleochroism, but actinolite very little. Next to quartz felspar and pyroxenes, amphibole is the most widely distributed mineral to occur in dark-coloured ferruginous rocks or moulding sands. It is generally found in rocks with a large percentage of SiO_2 and orthoclase. Under heat hornblende changes to augite. Tremolite and actinolite chiefly occur in contact rocks and crystalline schists, or as a result of the alteration of olivine into serpentine. Crystals of hornblende being among the first to form in eruptive rocks, often suffered corrosion by the magma, thereby causing a dark border. Most amphiboles are insoluble in HCl. Specific gravity 2.9 to 3.13. Hardness 5 to 6. Recent glacial drift deposits of moulding sands show a high amphibole content, as it usually alters to chlorite and other secondary products. Amphiboles have a low fusing

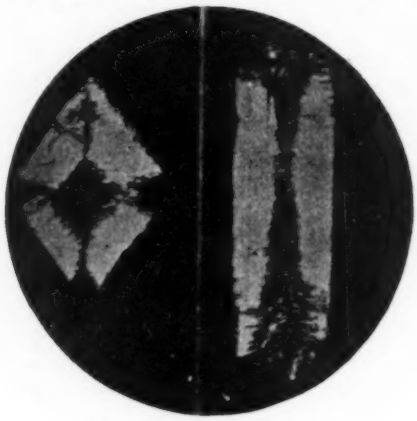


FIG. 17.—CHIASTOLITE.
(From Luquer and Cohen).

point, hence not desirable in moulding sands.

Mica.—A doubly-refracting biaxial mineral of eight varieties, viz., biotite, anomite, phlogopite, zinnwaldite or lithionite, lepidolite, muscovite, paragonite, Chromium mica. Anisotropic and monoclinic, met with in moulding sands as biotite, muscovite, and sericite or damourite. Muscovite, a white or potash mica, is a hydrated potash aluminium silicate, viz., $Si_6Al_6K_2H_4O_{24}$. Usual ap-

FIG. 19.—ENSTATITE.
(From Luquer).

pearance in scales, which may be notched or jagged with lateral sections or shreds. Colourless to greenish, very perfect cleavage. Index of refraction 1.564 to 1.618, between bromoform and moniLenzol. Muscovite is insoluble in HCl. It is a rare primary mineral in eruptive rocks except in granite, though as a secondary mineral it occurs in dense scaly aggregates as pseudomorphs after felspar. Like the felspars, micas are the most charac-

teristic minerals of dynam-metamorphic origin. Specific gravity 2.7 to 3.2. Hardness 2 to 3. Separation of micas is difficult on account of their scaly nature. Biotite is rare in moulding sands, as it quickly alters to limonite of chlorite on weathering, though muscovite can be generally observed. Fusing at 1,230 deg. C., it has a tendency to depreciate the value of a moulding sand. Sericite or damourite is a secondary product usually occurring in fine colourless scaly aggregates in phillites and sericite schists.

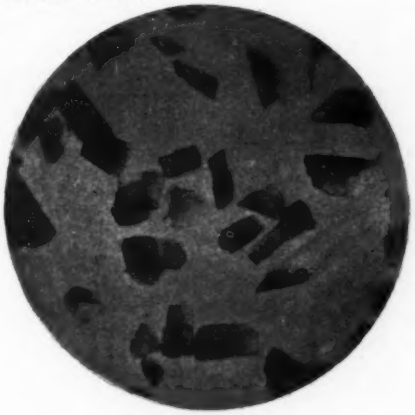


FIG. 20.—AUGITE.
(From Hatch and Rastall).

Chlorite.—A doubly-refracting biaxial mineral of four varieties, viz., pennine (rippidolite), clinochlore, kammererite, delessite. The former is $H_8(MgFe)_5(AlFeCr)_2Si_3O_{18}$; the others contain an excess of chromium and FeO respectively. Usually derived by the alteration of mica, pyroxene, and amphibole. Index of refraction 1.576 to 1.588, hence no marked relief and only slightly rough surface. Very perfect cleavage like mica. Pleochroism more marked in the dark-coloured varieties. Chlorites are essentially secondary minerals derived from aluminous silicates, biotite, garnet, augite, felspar, etc. Found in abundance in contact rocks and chlorite schists, acted upon by hot HCl and easily decomposed by H_2SO_4. Specific gravity 2.6 to 2.96. Hardness 2 to 3.

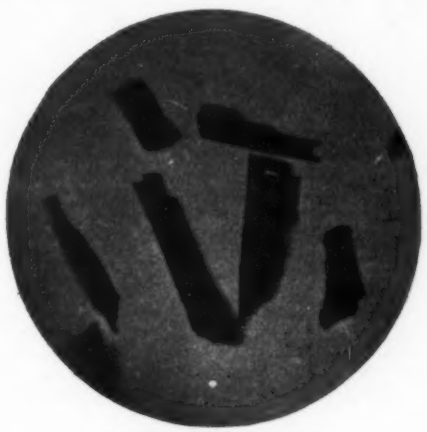


FIG. 22.—HORNBLENDE.
(From Luquer and Cohen).

Serpentine.—A doubly-refracting biaxial mineral of three varieties, viz., serpentine (chrysotile), bastite and antigorite, being a hydrated magnesian silicate $H_4Mg_3Si_2O_9$, with some replacement by Fe. usually appears as dense fibrous or scaly aggregates. Colourless to very light green, except the Fe variety, which is quite green. Index of refraction approximately the same as balsam, *i.e.*, 1.56, therefore surface smooth and no relief. Little or no

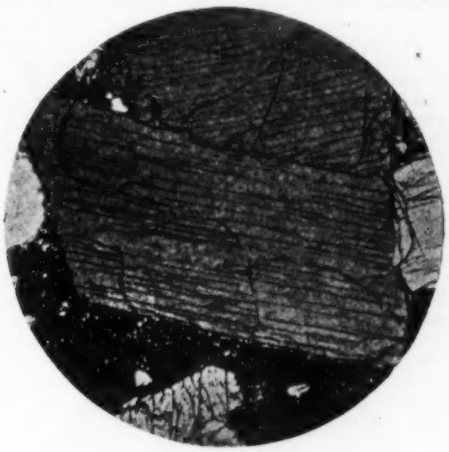


FIG. 21.—AUGITE.
(From Luquer and Cohen).

pleochroism except with the variety rich in Fe. Serpentine is a secondary mineral found in the altered basic igneous rocks, pyroxenites peridotites, etc., strongly attacked by HCl. and H_2SO_4. Hardness 2.5 to 4. Specific gravity 2.5 to 2.7 Occasionally found in moulding sands as microscopic yellowish flakes.

Felspar.—A doubly-refracting group of biaxial minerals divided into three groups, viz., orthoclase,

FIG. 23.—HORNBLENDE.
(From Luquer and Cohen).

microline and plagioclase, which are sub-divided into further groups. Next to quartz felspar ranks second in abundance and distribution in moulding sands. Orthoclase is anisotropic and monoclinic; is a potash aluminium silicate $K.AlSi_3O_8$, with some replacement by Na. Usual appearance in crystals and grains, though the dimensions of former are very variable. Colourless, unless tinged with oxide of

iron, though, if decomposed, cloudy. Index of refraction, 1.519 to 1.525, therefore surface smooth and no relief. Variable cleavage, and sometimes only seen in very thin sections. Although inclusions may be present and arranged in regular order, they are unimportant and do not occur in individuals of a second generation. No pleochroism. Varieties of the felspar group are the widest distributed of rock-forming minerals, and their recognition is most important. Insoluble in acids. Hardness, 6 to 6.5. Specific gravity, 2.56. During heat treatment of felspar crystals, the axial angle decreases to 0 deg., then increases in the plane of symmetry (at right angles to its former position). On cooling the axial angle returns to its former position if the temperature has not exceeded 500 deg. C. If the temperature rises from 600 to 1,000 deg. C., the axial angle will not return to its former position. In many moulding sands grains are often seen whose composition is made up of alternating layers of orthoclase and plagioclase, to which the name microporthite is applied; also intergrown with quartz forming pegmatite and micropegmatite (see Fig. 24).

Microline.—Anisotropic, triclinic. Also a potash aluminous silicate, but differently crystallised to orthoclase. Composition, $K.AlSi_3O_8$. Usual appearance, in the form of irregular grains. In general, microline is like orthoclase, and distinguished from it and plagioclase by a peculiar gridiron structure between crossed nicols. Colourless. Perfect basal cleavage. Index of refraction, low, 1.519 > benzol to 1.526 clove oil. Found with orthoclase, often replacing it in granite, syenite, gneiss, etc., being one of the last minerals to form. Insoluble in acids. Specific gravity, 2.56.

FIG. 24.—MICROPEGMATITE.
(From Luquer and Cohen).

Plagioclase.—Anisotropic, triclinic. Sub-divided into Albite, Oligoclase, Labradorite and Anorthite.—Usually a soda, lime, or soda-lime aluminium silicate, $Na_2Al_2Si_6O_{16}$. In appearance much the same as ortohclase. Lath-shaped forms and microlites being very common. Indices of refraction, albite 1.535, oligoclase 1.541, labradorite 1,557, anorthite 1.583.

Kaolinite.—A doubly-refracting biaxial mineral, being a hydrated silicate of alumina, $H_4Al_2Si_2O_9$. Is an alteration product derived through the decomposition of felspars. Usually seen as fine scaly colourless aggregates, which appear opaque, due to a porous structure. Index of refraction is about the same as balsam, i.e., 1.55, hence no relief. Scales slow local cleavage. Insoluble in HCl, but decomposed by H_2SO_4. Specific gravity, 2.6. Hardness, 2.5. (See Fig. 25.)

Magnetite, or magnetic iron ore, Fe_3O_4. Usually appears as grains and crystals generally of octahedral form. Opaque, and by reflected light, bluish black, with strong metallic lustre. Easily distinguished from hematite, chromite, ilmenite and graphite by a magnet. Soluble in HCl. Hardness, 5.5 to 6.5. Specific gravity, 4.9 to 5.2. Common in moulding and beach sands. Fusing point, 1,260 deg. C.

Hæmatite.—An oxide of iron Fe_2O_3. Largely present in moulding sands as earthy red or rusty brown masses. Opaque, and, by reflected light, black, with metallic lustre, or red without lustre. May also be transparent in acid eruptive rocks, crystalline schists, etc., also as inclusions in minerals, and as a red pigment in many rocks. Insoluble in HCl and non-magnetic unless attached to grains of magnetite. Hardness, 5.5 to 6.5. Specific gravity, 4.9 to 5.3. Index of refraction, 2.94 > sulphur in methylene iodide. Hæmatite fuses at 1,300 deg. C.

Pyrite.—A sulphide of iron, FeS_2. Isometric. Usually appears as cubes, pentagonal, dodecahedrons or in irregular grains. Opaque, and, by reflected light, bright yellow with strong metallic lustre. Alters easily to oxide of iron. Not very common in surface moulding sands, being found chiefly in quarries. HCl has little effect on same. Hardness, 6 to 6.5. Specific gravity, 4.9 to 5.2.

FIG. 25.—KAOLINITE.
(From Ries).

Limonite.—An oxide of iron hydrated, $Fe_2(OH)_6$, Fe_2O_3; frequently quite impure. Amorphous. Usual appearance, brownish and opaque, but may be translucent. Largely present in moulding sands. As the surface waters containing organic acids rapidly dissolve iron, so do the waters when percolating downward precipitate the iron as a hydrated iron between the sand grains. Therefore, most moulding sands have their grains thickly coated with limonite.

(To be continued.)

THE BRITISH ALUMINIUM COMPANY, LIMITED, 109, Queen Victoria Street, London, E.C., have sent us a pamphlet relating to the application of aluminium in the electrical railway world.

MR. W. H. ROBINSON has been appointed works manager to Brown Bayley's Steel Works, Limited, Sheffield. Mr. Robinson is the son of the late Mr. Richard Robinson, who so successfully acted as works manager at the establishment for more than 30 years.

Tests of Cupola Gases and Temperatures.

A report on "Foundry Cupola Gases and Temperatures," prepared by Mr. A. W. Belden, covering tests made at the Government Experimental Station at Pittsburgh, has been issued by the United States Bureau of Mines.

Melting losses of iron have been fully appreciated but little understood. The fact that these losses were possible with either light or heavy coke led to the belief that by using small charges so placed that melting would take place in that zone of the cupola where the highest heat and the smallest percentage of oxygen prevailed and by confining all melting to this zone these losses would be eliminated and the economical use of practically any coke produced for metallurgical purposes would become possible. This widening of the field from which coke might be drawn for foundry purposes would serve to place the foundryman in an independent position as regards his source of supply, and would tend to conserve the better grades of coking coals, which are being rapidly exhausted, by making the poorer grades available for mixing with them.

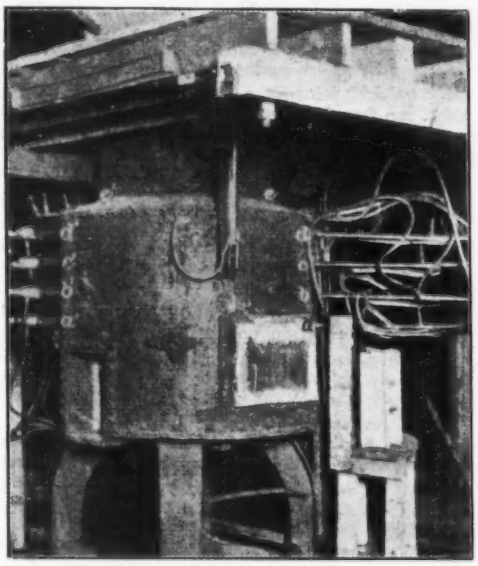


FIG. 1.—SHOWING POSITION OF TUBES IN CUPOLA.

In order to investigate conditions within a cupola, the Bureau of Mines as a first step decided to install a commercial cupola, to sample the gases during their travel from the tuyeres upward, and to determine the temperature of the fuel bed. A 36-in. standard Whiting cupola was installed. Upper and lower tuyeres were provided, but the upper ones were not used in any of the tests. The four lower horizontal tuyeres measured 4 in. by 6 in. on the outside and 3 in. by 13 in. on the inside of the cupola, and were 14 in. above the bottom. During tests the sand bottom was brought up to within 3 in. of the bottom of the tuyeres in order to save as much coke as possible. The tuyere area was 96 square inches, and the area of the cupola, lined to 27 in. internal diameter, was 573 sq. in., a ratio of 1 to 5.96.

For the purpose of investigation the cupola was considered as divided into sections by four imaginary horizontal planes, situated as follows:—One inch above the top of the inner opening of the tuyeres, and 7, 13 and 19 in. above the top level of the tuyeres. Two-inch holes, as shown in Fig. 1 at *a*, *b*, *c* and *d*, were cut through the blast box and inner shell along the lines at which the planes intersected the wall. Through each hole a 1¼-in. pipe 10 in. long was passed, the inner end extending 1 in. past the inner shell into the brick lining, the outer end, extending 1 in outside the blast box, being threaded to take a cap adapted to fit tightly the sample tube when inserted. The pressure was not sufficient to cause leakage through to the fuel bed, and all air admitted to the cupola passed through the tuyeres. On the opposite side of the cupola at points designated as a^1, b^1, c^1 and d^1 (Fig. 1), holes were cut at levels corresponding to those represented at *a*, *b*, *c* and *d*, and were fitted with 3-in. pipes similarly to those just described.

A reciprocating counter attached to the main shaft of the Roots blower gave an accurate means of determining the revolutions, a Pitot tube connected to a recording pressure gauge indicated the pressure at any time or the average over any period of time, and calculation gave the total volume of air delivered. In order to make the tests independent of possible delay and of overload difficulties, use of the line shaft was discontinued and a 10-h.p. motor was installed for operating the blower.

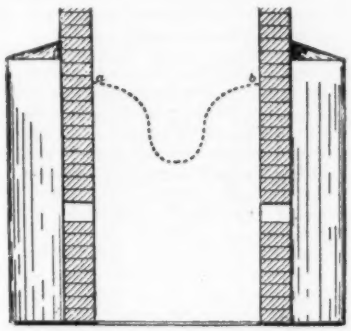


FIG. 2.—PROBABLE LINE OF HIGHEST TEMPERATURE.

In all tests, whether relating to the character of the gases or to the temperatures, the cupola was lined to 27 in. internal diameter. Coke alone, without iron or flux, was used. The investigation being designed to furnish data as to the action of the fuel, it was necessary to consider only that part of the cupola below and including the melting zone. Complications from the use of iron were thus avoided, and the experience of ordinary commercial practice does not indicate that the addition of this material would seriously affect the results obtained from coke alone. The sand bottom was brought up to within 3 in. of the bottom level of the tuyeres, and the tubes for collecting gas or measuring temperature were put in position. About 24 in. of coke was placed upon sufficient wood for kindling. The fire was lighted and the coke allowed to ignite and burn until the top showed bright. Coke in small quantities was added from time to time until well above the top tube, each succeeding charge being held until the preceding charge had burned through. After the last small charge had

been added, sufficient time was given to ensure its burning evenly over the whole surface of the bed, thus indicating that the burning was over and through the whole bed of coke and was not localised as sometimes happens when proper precautions are not taken. The kindling wood was always completely burned before the last coke was added. This last addition of coke brought the top of the charge to within 6 in. of the charging door. The total weight of coke charged was approximately 750 lbs. for each test. Ten minutes after the last coke had been added the blast was turned on and was continued for 15 minutes before the test began.

Preliminary tests were made with varying volumes of air per minute, the results suggesting the use of 1,000 cubic feet per minute as a normal condition. As the 36-in. cupola, lined to 27 in., can melt about 2 tons of iron per hour, 1,000 cubic feet of air per minute checks well with the usual assumption that 30,000 cubic feet of air is required to melt a ton of iron. The varying pressures due to different sizes of coke, the position of pieces of coke with reference to other pieces and the side walls, the effect of slagging and hanging and of other conditions, made impossible the exact regulation of the air supply, but the average of all tests approximated 1,000 cubic feet per minute.

The actual combustion of the fuel takes place in the fuel bed around a region having the shape of an inverted cone; the apex of this cone is at the centre on the level of the bottom of the tuyeres and its surface flares out to the lining at a point 20 in. above. If melting be kept above the base of this cone, no oxidation will occur.

Measuring temperatures in the fuel bed of the cupola presents many difficulties and all attempts to get actual temperatures failed.

The ideal melting region probably corresponds to that lying along and just above the line, *a b*, Fig. 2. This line includes points representing those points in the cupola having highest carbon-dioxide content together with an absence of oxygen, as determined from analysis of the gases. It is manifestly impossible to confine melting to such a region, and the logical conclusion from the experiments is that the best results are obtained if the iron is melted at that region in the cupola where the highest temperature, together with an absence of oxygen, exists across the whole fuel bed. The bottom of this region in the cupola tested was 19 in. above the tuyeres when 1,000 cubic feet of air per minute was being blown. This region will be raised if the blast is increased and will be lowered if the blast is reduced. Experimental determination of this region is not necessary; in practice, the bellying-out of the lining of the cupola is a perfect index of the position of the melting zone, and this bellying is in the region where temperature is highest and oxygen is absent.

Care must be taken not to melt below the bottom of this region, for the oxygen of the blast not being entirely removed, the iron will be oxidised or burned. The extent of this burning is dependent on the distance below the proper melting region and the lateral position in the fuel bed. Just below the bottom of this melting region oxygen is still found at the lining and the cross-sectional area of this oxidising region increases as the distance downward increases until the whole cross-section at the tuyeres shows the presence of this damaging element.

The whole problem of obtaining hot iron, free from effects due to oxygen, is solved by using small charges evenly distributed on the fuel bed, and confining the melting to a few inches above the plane shown by the burning out of the lining to be the hottest plane of the fuel bed. If the first charge of iron is so placed that melting begins, say, 4 or 6 in. above this plane and is completed before any of the iron gets below it, and if the following coke and iron charges are so regulated as to maintain this melting zone, the best possible results will be obtained.

The experiments here reported indicate further that the use of upper tuyeres is not only unnecessary but a positive detriment to the production of the best iron. The introduction of air into the fuel bed above the tuyeres, even though in small volume, increases the liability of injurious effect from oxygen and serves no useful purpose. The increased tonnage supposed to be obtained by the use of upper tuyeres can be produced just as easily by blowing through the bottom tuyeres the proper volume of air.

Hints for Young Patternmakers.

Make your pattern to satisfy the moulder, *not* your imagination. Imagination is often a cheerful but misleading friend.

A pattern to a moulder is a tool for producing castings; therefore make it as effective as possible.

A "quick" job in the pattern shop may be a slow job in the foundry. It is your job to reduce as much as possible foundry expenditure by producing "workable" patterns.

Pattern experiments at the cost of the foundry are much more interesting when done by "the other fellow."

Don't pity the moulder because he cannot read a drawing. To him it is an advantage but not a necessity.

Rushing your work may affect your bonus, but it may also affect your craftmanship—disastrously.

Varnish does not produce a smooth surface on the pattern; its object is to resist the effects of moisture. The smooth surface must be obtained first, and requires skill, patience and sharp tools.

A blunt tool is like a nagging woman; it only creates friction without producing any good effect.

Glasspaper is required to finish off the work of the tools, but is not a planing machine. Use it judiciously, for it costs money.

Screws properly driven home are more effective than nails, but require a screw driver, *not* a hammer. You may think it quicker, until the screw head comes off.

Nails are easily driven in, but often take a lot of getting out, when they may prove to be more costly than a gross of screws. Know when *not* to use them.

Glue is only a means to an end. Don't depend upon it as the only means to hold a pattern together. Glue in contact with moisture loses its nature, and for some work may prove useless.

Wax is very useful for filling up screw-holes, making small fillets, etc., but it is neither necessary nor desirable to form portions of the pattern with this material.

Dowels should be a sliding fit, *not* "just a bit tight"; this "just a bit tight" may ruin a mould during lifting.

Don't think every young apprentice or "old hand" is a fool. You can learn from both.

You may envy the philanthropist—and you may be one if you will. A word of advice and encouragement to a young apprentice is worth more than gold.

Engineering Research and its Co-ordination.*

By G. H. Roberts.

Woolwich Arsenal comprises not only the Ordnance Factories but also the Inspection and Stores Departments of the Army and Navy. The Ordnance Factories themselves comprise three large manufacturing establishments engaged in the production of various warlike stores for the Army and Navy, and as each factory is more particularly concerned in its own specialised class of manufacture, it follows that the researches and investigations undertaken by the laboratories attached to each are to some extent special to their own productions. Owing, however, to the considerably increased complexity in the design and the number and variety of material employed in the manufacture of warlike stores in recent years, a certain amount of overlapping in the research work so carried out became unavoidable, and, with a view to obviating duplication as far as possible, and also to assist in keeping the several departments in touch with similar work in progress, both in the Ordnance Factories and elsewhere, arrangements were made some time ago for these experimental researches to be collated for the information of all departments. At the same time, steps were taken to ascertain what investigations of similar nature had been carried out elsewhere and made public, and to see how these compared with the results obtained in the Ordnance Factories.

Standard Tensile Specimens.

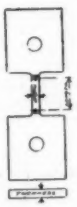
The standard shapes and sizes of tensile test specimens originally proposed by the Engineering Standards Committee some years ago are now well known and largely adopted. It is well known that the recommendations of the Engineering Standards Committee were largely based upon Barba's Law of Similarity and upon a large amount of experimental work carried out specially by Professor Unwin, subsequently published in the Engineering Standards Committee Report No. 3. The standard proportions previously laid down and used by the War Department did not altogether conform to the Engineering Standards Committee recommendations, however, and as the various Government Departments were pledged to the adoption of the latter, whilst owing to the extremely wide range of materials purchased by the War Department it was not possible in many cases to obtain specimens to the Engineering Standards Committee dimensions, and as there still existed a certain amount of doubt as to whether the above law held good in such extreme cases, it was decided to carry out some experiments on the point. It is not necessary to give the details of these, which are not otherwise of general interest, but the results showed that the law was substantially correct, even for extremely small sections, and as a result a Table of Proportions was drawn up (Fig. 1) for round specimens ranging from 0.160 in. to 0.564 in. diameter, and for flat specimens ranging from 0.1 in. to 0.3 in. thick. The other dimensions are all such that the relationship, acting length $= 4\sqrt{\text{area}}$, held good. The above standards were finally adopted in 1904, and have been adhered to ever since.

It will be noticed that in all cases the areas are convenient submultiples of a square inch, a fact which saves much time, and makes for greater accuracy in working out the results. By the introduction of suitable limit gauges with fine limits, no difficulty has been experienced in the production, at a reasonable cost, of specimens with the necessary degree of accuracy.

Instrument for Indicating Yield Point of Tensile Specimens.

In certain War Department specifications for steel it is the practice to specify, not only the customary requirements with regard to tensile strength and elongation, but also a minimum value for the yield point, and the instrument shown in Fig. 2 was devised for the purpose of conveniently and readily showing this. It consists of an aluminium body fitted with two steel jaws, one fixed to the body of

Test Piece Number	1	2	3	4	5	6
Dias	·564"	·461"	·399"	·326"	·282"	·160"
Area	1/40"	1/60"	1/80"	1/120"	1/160"	1/320"
Length	2·0"	1·833"	1·610"	1·333"	·899"	·556"



Test Piece Number	7.	8.	9.	10	11.	12.	13.	14.	15
Width	·278"	·303"	·333"	·370"	·25"	·486"	·135"	·16"	·20"
Thickness	·3"	·275"	·25"	·225"	·2"	·172"	·15"	·125"	·1"
Area	1/12"	1/16"	1/12"	1/10"	1/20"	1/20"	1/100"	1/100"	1/100"
Length	1·55"	1·55"	1·55"	1·55"	·899"	·899"	·556"	·556"	·556"

FIG. 1.—FORMS OF TEST PIECES ADOPTED AS STANDARDS IN THE ROYAL ORDNANCE FACTORIES, WOOLWICH.

the instrument, and the other sliding in a long deep groove and forced outwards by a spring. The movement of the sliding jaw is communicated to the pointer on the dial, the leverage being such that one division on the dial corresponds with 0.001 in. movement between the shoulders of the specimen, and as the divisions on the dial are each about 0.1 in. long it is quite possible, if so desired, to estimate to 0.00025 in. A suitably arranged spring obviates any difficulty arising from back-lash.

In use, the specimens are all prepared to definite lengths, for which check gauges have been made. The specimen is placed in the testing machine, the instrument is pressed in between the shoulders of the specimen and held in position by the observer whilst the test proceeds. As the load is gradually applied within the elastic limit, the movement of the pointer is uniform, but as soon as the yield point is reached the pointer takes a jump. The simultaneous load requires to be noted on the testing machine.

The instrument requires a certain amount of skill and experience on the part of the observer when used with the ordinary class of ductile materials, but even with such things as steel castings which give

* Abstract of Paper read at the Cambridge meeting of the Institution of Mechanical Engineers.

comparatively low percentage elongations, the yield point is very clearly indicated by the instrument. The range of adjustment is, of course, small, but owing to the fact that all tensile specimens are made to one or other of six standard lengths (see preceding

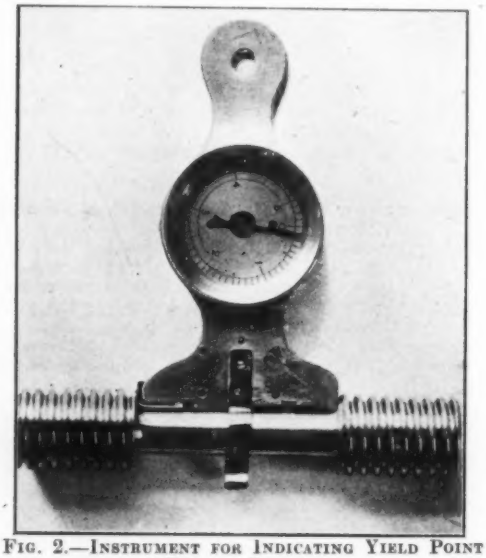


FIG. 2.—INSTRUMENT FOR INDICATING YIELD POINT OF TENSILE SPECIMENS.

remarks and Fig. 1) only that number of instruments are required, and as they are cheap to manufacture and are subject to little or no wear, this is not a great objection.

when tested in different testing machines, and it was thought that this difference might be due to the fact that the specimens were being tested at different speeds. A series of tests were accordingly carried out at different speeds, one set in a Whitworth testing machine. The experiments were arranged to be as nearly as possible on similar lines otherwise and the results, when averaged to some extent, are shown on the attached curves, Fig. 3. The general conclusion arrived at was that, for steels of the quality under consideration, small differences in the speed of breaking specimens, such as might obtain in ordinary practice with reasonably careful manipulation, had little, if any, appreciable effect in the value of either yield point, breaking load, or elongation.

Experiments on Aluminium Alloys.

For certain purposes it was required to produce a material which should possess the following properties to as great an extent as possible :—(1) Low specific gravity; (2) good tensile strength and elongation; (3) be reasonably easy to machine and capable of taking a good finish; (4) capable of being cast in either chills or sand moulds. Although the alloys previously used had proved fairly satisfactory in the above respects, it was desired to see whether something even better could not be obtained, and the experiments detailed in Table I were undertaken. The alloys were melted in plumbago crucibles and cast in the manner stated. The tensile specimens were 2 in. long by 0.564 in. diameter, while the compression specimens were 0.799 in. diameter by 1 in. high. Alloys Nos. 10, 11, and 12 were produced by the use of silicon-copper having the composition Cu 60 per cent., Si 40 per cent. Alloys Nos. 22 and 23 were produced by the use of manganese copper having the composition Cu 80 per cent., Mn 19 per cent., with 1 per cent. iron. Taking the whole

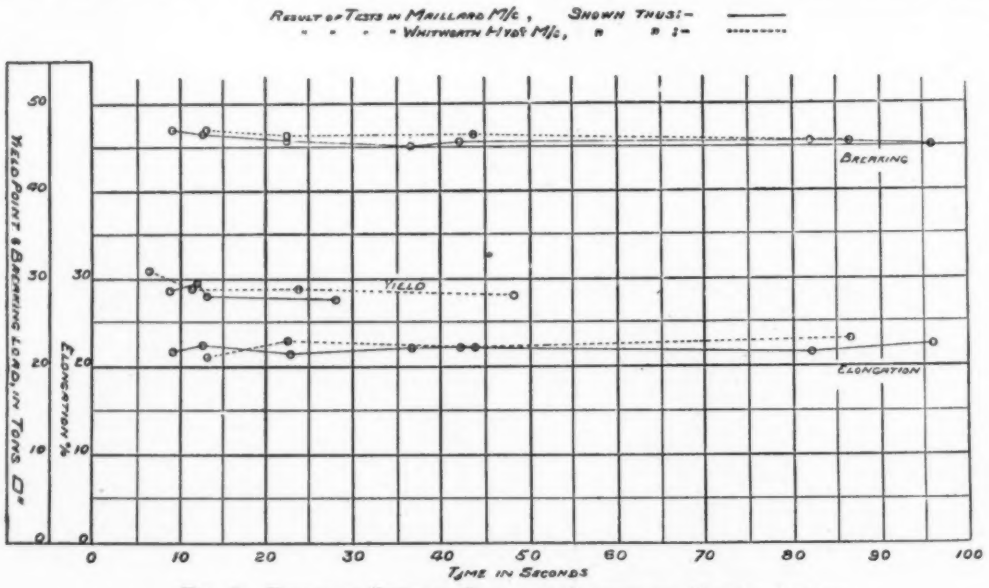


FIG. 3.—EFFECT OF SPEED OF TEST UPON RESULTS IN TENSILE TESTING.

Effect of Time Factor upon Results of Tensile Testing.

In the testing of certain steels, differences had been noted in the results obtained from similar steels

series of experiments, it will be seen that only No. 8 gave good all-round results.

About the same time that the above experiments described were in progress, a requirement arose for

the production of aluminium castings of somewhat intricate design. A number of experiments were carried out, the more important of which are summarised in Table II. The results obtained from the mixing No. 8 were so good that this mixture was adopted as a standard for certain classes of castings and given the distinctive name of "Calaminium." It has a specific gravity of about 2.85.

A somewhat remarkable and interesting feature, noticed in the search for references to other similar work, was the variety of distinctive names given to the light aluminium and magnesium alloys. These include "Magnalium," "Wolframinium," "Zisium," "Ziskon," "Romanium," "Electron," "Sulphalium," "Duralumin," "Partinium," "Atherium," "Clarus," "Vanalium," etc.

TABLE I.—*Specimens Cast in Iron Mould.*

No. of Test.	Mixing.	Tensile strength. Tons per sq. inch.	Per cent. Elongation.	Yield-point in crushing. Tons per sq. inch.	Machining qualities.
1	Aluminium .. 80 Zinc 20	15 3	5 0	9.0	Fairly good.
2	Aluminium .. 80 Zinc .. .. .. 19 Copper 1	14.9	6.0	9.4	Fairly good.
3	Aluminium .. .. 67 Zinc .. .. .. 33 Copper 2	22.1	3.0	18.2	Good.
4	As No. 3	20.5	3.0	18.8	Good.
5	Aluminium .. .. 78 Zinc .. .. .. 20 Copper 2	13.9	3.7	10.4	Fairly good.
6	Aluminium .. .. 77 Zinc .. .. .. 20 Copper 3	16.8	4.5	11.5	Good.
7	Aluminium .. .. 76 Zinc .. .. .. 20 Copper 4	15.3	3.7	10.4	Fairly good.
8	Aluminium .. .. 79 Zinc .. .. .. 19 Copper 2	16.5	6.5	10.4	Good.
9	As No. 8	16.5	5.0	15 2	Poor.
10	Aluminium .. .. 96 Silicon copper .. 4	10 3	6.0	5.0	Poor
11	Aluminium .. .. 85 Zinc .. .. .. 13 Silicon copper .. 2	10.9	2.5	8.1	Poor.
12	Aluminium .. .. 80 Zinc .. .. .. 18 Silicon copper .. 2	12.8	1.5	11.9	Poor.
13	Aluminium .. .. 98 Magnesium 2	9.4	7.2	5.0	Poor.
14	Aluminium .. .. 96 Magnesium 4	9.4	4.2	7.0	Poor.
15	Aluminium .. .. 80 Magnesium .. .. 5 Zinc 10	7.1	Nil	17.5	Poor
16	Aluminium .. .. 85 Magnesium .. .. 5 Zinc 10	9.75	1.0	15.6	Poor
17	Aluminium .. .. 80 Manganese bronze .. 20	11.7	1.0	11.4	Poor.
18	Aluminium .. .. 85 Manganese bronze .. 15	10.9	2.5	9.1	Poor.
19	Aluminium .. .. 90 Manganese bronze .. 10	10.9	10.0	4 55	Poor.
20	Aluminium .. .. 90 Zinc .. .. .. 5 Manganese bronze .. 5	10.9	8.25	4.65	Poor.
21	Aluminium .. .. 85 Zinc .. .. .. 10 Manganese bronze .. 5	11.5	6.25	5.85	Poor.
22	Aluminium .. .. 85 Zinc .. .. .. 10 Manganese copper .. 5	9.1	1.5	8.3	Poor.
23	Aluminium .. .. 85 Zinc .. .. .. 12 Manganese copper .. 3	10.85	2.75	7.15	Poor

Unification of Methods of Reporting.

Although the author has for many years past been of opinion that considerable simplification might be effected with advantage in the forms used for reporting results of the more usual kinds of testing, the search for references to similar work mentioned above emphasised the desirability of some such standardisation. It was found that, generally speaking, the different forms used gave substantially the same information, but there was such a diversity in the method of setting out the main features that not only was considerable difficulty and waste of time incurred in recasting and assimilating the information given, but difficulty was also experienced at times in comparing results obtained from various sources.

The author would not wish it to be understood that he advocates the use of stereotyped forms for every conceivable type of testing, but he does think that, for a very large proportion of testing now commonly carried on, standardised forms would in all cases serve the purpose in view equally as well as the various forms now used, and would also in most cases offer considerable advantages in saving of time and general convenience. To take a concrete case. It is probably not an exaggeration to say that

TABLE II.

Consecutive Number	Mixing.	Tensile Tests. Elastic limit. Tons per sq. inch.	Tensile Tests. Ultimate strength. Tons per sq. inch.	Tensile Tests. Percentage elongation on 2 inches.	Remarks.
1	Aluminium with about 0·7% nickel and 0·7% copper	N.O	10·0	6·0	—
2	Above metal recast	N.O.	4·3	5·0	Cast in iron moulds. Metal too hot.
3	85% Aluminium and 15% zinc	6·3	11·2	6·0	Cast in chill.
4	„ „ „ „ „	8·2	11·5	3·5	„ „ „
5	„ „ „ „ „	8·3	9·2	2·0	Cast in sand.
6	„ „ „ „ „	7·0	10·7	5·0	Cast in chill.
7	80% Aluminium and 20% zinc	—	10·2	Nil	„ „ „
8	94% Aluminium, 4·1% zinc, and 2·15% copper	4·6	10·0	15·0	„ „ „
9	85% Aluminium and 15% zinc	9·1	10·9	2·0	Cast in sand.
10	95·44% Aluminium, 2·28% nickel and 2·28% copper	6·6	9·4	2·5	Cast in chill.
11	85% Aluminium and 15% zinc	8·9	10·5	2·0	Cast in sand.
12	„ „ „ „ „	—	7·7	2·0	Defective castings.
13	„ „ „ „ „	—	7·6	1·0	
14	„ „ „ „ „	10·1	11·3	3·0	Cast vertically.
15	„ „ „ „ „	8·2	10·5	3·0	—
16	„ „ „ „ „	—	16·8	0·7	—
17	„ „ „ „ „	12·9	13·9	1·2	—
18	„ „ „ „ „	6·7	7·7	1·5	Cast horizontally
19	„ „ „ „ „	10·1	11·3	3·0	Cast vertically
20	„ „ „ „ „	14·6	15·0	0·7	—
21	„ „ „ „ „	17·1	18·6	1·7	—
22	„ „ „ „ „	14·7	16·8	1·7	—
23	„ „ „ „ „	—	14·8	—	—

ordinary tensile tests form 90 per cent. of the tests carried out by an inspecting engineer in the ordinary course of his duties at steelmakers' or engine-builders' works, yet it is a matter of common knowledge that each works he visits has its own particular type or form of test-sheet, although the information required and given is practically the same in each case. Only those whose duty it has been to scrutinise and compare large numbers of such test-sheets can realise the amount of time so wasted and the irritation produced with no useful purpose served, and for no apparent reason. Typical examples of two forms are shown herewith, Tables III. and IV., which have been in use in substantially the present form for some considerable time, and found to meet all ordinary requirements. These forms are about 13 in. by 8 in., so that they are of a size convenient for filing in the Stolzenberg, or other similar filing systems now so largely used. The relative amount of space to be given to each column is not indicated on the form as shown, but can be easily adapted to suit requirements, whilst some of the heads which are not often required, such as yield point, load, and stress, may be omitted altogether.

Tensile Testing.

In the form shown, Table III., the upper portion contains spaces for all the information as regards order numbers, customers, etc., which it is usually necessary to give on such sheets. In the body of the form an endeavour has been made to keep together :—(1) Those heads of information which are purely observational and require to be taken at the testing machine; (2) those heads which can be left to be worked out in the office subsequently with the help of the slide rule or Tables.

It might also be noticed that with this arrangement all the information with which the inspector or consultant is ultimately concerned is shown in the last six columns, which are brought together and the results seen at a glance, instead of, as is frequently the case, requiring to be picked out from a lot of other figures which are of secondary importance. It will be observed that the form is primarily intended for use, say, in a steel works; it can, however, be conveniently used for ordinary testing carried on in one's own works, in which case the upper headings will not apply and indeed need not be printed on the form. The primary object of the standardised form will, however, be fully met in that the observed and deduced results will be given in the same relative positions.

TABLE III.

Tensile Tests of Materials carried out at .....

Order No. ..... Customer's Name ..... Rolling Mill or Casting No. .....

Date of tests.	Identification number.	Description of Materials.	Acting length.	Original Sections.		Breaking load in tons.	Yield-point load in tons.	Ultimate length.	Fractures.		Maximum stress.	Yield-point stress.	Percentage elongation.	Percentage contraction of area.	Appearance of fracture.	Remarks.
				Dimensions in inches.	Area in sq. inches.				Dimensions in inches.	Area in sq. inches.						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Specification requirements.																

Tested by ..... In the presence of ..... Certified by .....

Date .....

Transverse Testing.

Although transverse tests are not so frequently carried out as are tensile tests, difficulty is frequently experienced, similar to that mentioned above, in apprehending at a glance the salient points of the results. A form is shown in Table IV. which should meet all the ordinary cases of transverse tests of cast iron, and also—with slight modifications as regards the progressive loads under which the deflections are measured—timber as well.

TABLE IV.

Transverse Tests of Materials carried out at .....

Order No. ..... Customer's Name ..... Foundry or Pattern Identification No. .....

Date of tests.	Identification numbers.	Description of Materials.	Distance between supports.	Dimensions in inches.		Deflection in inches at centre.						Breaking load at centre in pounds.	Deflection in inches at fracture.	Remarks.
				Breadth.	Depth.	5 cwt.	10 cwt.	15 cwt.	20 cwt.	25 cwt.	30 cwt.			
Specification requirements														

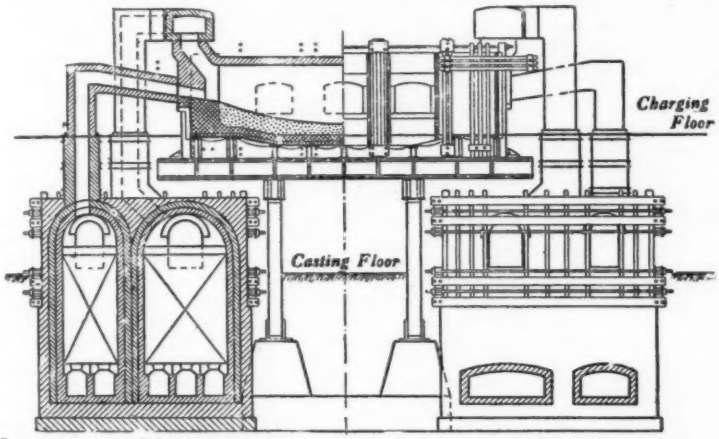
Tested by ..... In the presence of ..... Certified by .....

Date .....

Improvements in the Bernhardt Open-Hearth Furnace.*

By F. Bernhardt.

In the most recent form of this furnace (Fig. 1) for treating charges of hot metal, the actual ports of the ordinary open-hearth furnace (as shown on the left-hand side of Fig. 2) are dispensed with entirely.

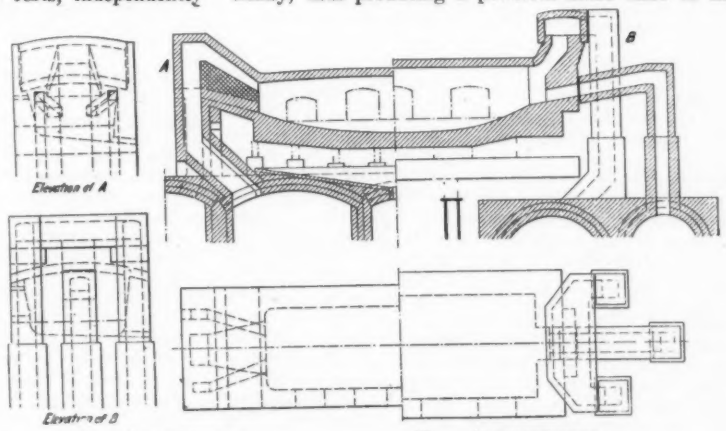


Longitudinal Section through Furnace and Chequers. Elevation on Charging Side.

Fig. 1.—Elevation (Partly in Section) of 50-Ton Furnace.

The supplies of air and gas are conveyed in the upward direction independently of the furnace, the former being led into a collecting chamber whence it is admitted into the furnace through a slit in the vault. This collecting chamber rests, independently of the furnace, on the metal fittings of the side walls of the latter; and both the ports connecting the furnace with the gas and air flues are arranged in such a manner as to be able to follow the movements set up in the furnace brickwork by changes of temperature. With this object they are merely bolted loosely to the furnace, and rest freely on the shafts, the space left for free play being filled with sand. The collecting chamber and the air and gas feed members, which may be built up of several sections, are detachable, and are formed of a framework of angle-iron and of a lining one brick thick. In place of the circular shape at first used, it has been found, by experience, preferable to make the gas and air flues of rectangular section, as offering advantages in respect of simplicity of construction and reduced frictional surface for the waste gases. In small furnaces the long massive port is replaced by a simple end wall 2 ft. thick, the thickness being increased to 30—40 in. in the case of large furnaces. In most cases this end wall has only a single opening for the admission of the gas (see Fig. 2, right-hand side), but several gas flues may be provided (Fig. 3) without lessening the durability of the wall.

The upper portion of the furnace is prismatic in shape, and is carried independently of the lower portion, by longitudinal girders which rest on two cross girders supported by four pillars, as shown in Fig. 1. The chambers are in pairs, and are independent of each other and of the furnace, so that the whole furnace is of the non-rigid type. This arrangement results in the following advantages:—The pointed tongues, which in the ordinary furnace burn away rapidly, are dispensed with. The end wall offers very few points of attack to the corrosive action of the waste gases. The arrangement of the air box enables the air to impinge at a very steep angle, almost vertically, thus producing a powerful flame close to the end wall. In consequence of the complete admixture of the gas and air at the head end of the bath, complete combustion of the gas is attained in the furnace itself, instead of being more localised at the further end, and therefore the end wall and vault of the



Old Arrangement. New Arrangement.

Fig. 2.—Old and New Arrangement of Flues.

* "Stahl und Eisen."

furnace are far less exposed to corrosion by the escaping gases. The point at which the gas and air meet cannot easily become displaced, and consequently there is greater uniformity in the supply of flame and in the working of the charge throughout the whole life of the furnace. At the same time the more intensive action allows the sectional area of the gas intake ports to be reduced by one-third in comparison with the ordinary furnace, and therefore the consumption of gas is lessened. The end wall is fully exposed on the outside, and its thickness being small, is effectually cooled by the cold external air. The steep bends in the vault, which are a source of trouble, are abolished. Owing to the possibility of arranging the gas intake at any height in the end wall, the bed of the hearth can be carried close up to the end, and the slopes in the bed, which are a source of trouble in repairing, can be made very short, thus saving lining material. The mutual independence of the flues, air boxes, end wall, furnace proper and the chambers, enables all these members to be in course of erection simultaneously, and the furnace to be enlarged by lengthening without any great expense. The furnace construction, as a whole, is simple and easily supervised, and the tie members need not be so heavy as usual. The low

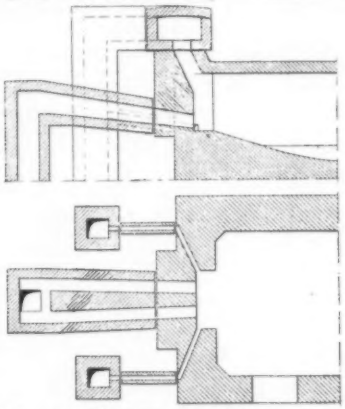


FIG. 3.—DOUBLE GAS INLET WITH ADMISSION OF AIR ALL ROUND; BERNHARDT FURNACE.

weight of the upper portion of the furnace enables the construction of the substructure to be simplified. The chamber arches, being relieved of pressure, are far more durable, and the arrangement of the chambers facilitates traffic underneath the furnace. The exposed hearth plates are effectually cooled by the external air, and in consequence of the reduced amount of slag in the chambers, their life is considerably lengthened, this being especially the case with the air boxes. The accessibility of all parts greatly facilitates repairs; the flues can be entirely or partially detached, and the air boxes can be replaced by a spare at any time. In repairing the upper portion of the furnace, the flues can be shut by plates of sheet iron or stone, to prevent the access of cold air and retain the accumulated heat; hence the furnace can be heated up again in a very short time. The end wall can be demolished and rebuilt quickly, the amount of material required being small; and all repairs can be executed without detaching the various parts—an important consideration in the case of steel works lacking suitable mechanical appliances. The improvements can be fitted to any existing open-hearth furnace.

The results of practical working show that the furnace can be kept in work at least twice as long as the ordinary type. For instance, a 35-ton furnace which formerly worked 450-500 charges between principal repairs is found to last out 700-800 charges, the end wall and air boxes having been renewed after 350-400 charges (involving a stoppage of two to three days). By "principal repairs" is meant the rebuilding of the whole superstructure down to the gas and air uptakes except the hearth, which endures several years. The chequerwork will stand 3,000 charges, and the gas and air flues 1,500-1,800 charges. As a result of the less frequent repairs the working life of the furnace is increased by 40 days in the year. A comparison from actual practice, between an ordinary open-hearth furnace and one of the Bernhardt type, each having a capacity of 35 tons, has shown that the latter ran for 672 charges whilst the other had to be repaired after 496 charges. The output from the Bernhardt furnace was the higher by 7,972 tons, whilst the repairs cost some £350 less, the resulting saving in the cost of production being equal to 9d. per ton of steel. The saving in magnesite and dolomite was nearly 2d. per ton, and the coal consumption was diminished by 5-10 per cent.

Fig. 3 illustrates an attempt to arrange a Bernhardt furnace, with two gas inlets, so that the gas shall be surrounded with air on all sides, thus increasing the activity of combustion and consequently reducing the consumption of coal. This is effected by introducing part of the air through auxiliary ports, arranged slantwise in the end wall and situated on either side of the gas inlets and partly below same. These auxiliary ports can be constructed up to 8 in. in width without arching, and therefore the construction of the end wall remains simple, and the durability of the furnace is in nowise affected. This furnace has only been running a short time, and though the results have proved satisfactory so far, it is too early to pronounce definitely on the advantage of the arrangement.

The total number of Bernhardt furnaces at work is nine. Two of these (50-ton furnaces) constructed for working with hot metal charges, produced an average of 185 tons each in 24 hours from pig-iron charges, the total output from the two furnaces during the first working month amounting to 9,434 tons.

Blue Printing by Electricity.

WE have received from the Westinghouse Cooper Hewitt Company, Limited, 80, York Road, King's Cross, London, N., an illustrated pamphlet dealing with their mercury vapour lamps as applied to blue printing. Mercury vapour lamps are almost universally used for photographic work, and the making of photo-copies of engineering drawings is no exception to this general application. The fact that the light is wholly actinic, and is uniform throughout the length of a long tube enables prints of exceptional quality to be obtained. The principle of this is similar to that of the modern newspaper press, consisting of a revolving cylinder of transparent glass, in the inside of which is the source of light. We understand these machines have been largely adopted, and have as their features absolute uniformity and exceptional quality of the work, with low consumption of current and absence of any mechanism in the lamp itself or in it soperation in the machine. This Company have also sent us a pamphlet dealing with their parallel burning lamp for tramway circuits of 500 volts.

Institute of Metals.

The autumn meeting of the Institute of Metals was held this year at Ghent, the proceedings being opened on August 28 and continued on August 29, in the Palais des Fêtes of the Ghent Exhibition. A considerable number of members and friends availed themselves of the facilities provided for attending the meeting.

The programme included an inspection (under Professor V. Renaud) of the Engineering and Metallurgal Sections of the Exhibition; a visit to the works of Messrs Van de Kerkhove and Carels Frères; a Municipal Reception of the members, etc.

The list of Papers read at the meeting comprises eleven items, of which the following are abstracts :—

Second Report to the Corrosion Committee.

The Second Corrosion Report, read at the meeting and summarised below, is of special importance. For more than three years the Corrosion Committee, under the chairmanship of Sir Gerard Muntz., Bart.,* have been at work on the subject of the corrosion of condenser tubes, the Committee's Honorary Investigator being Dr. G. D. Bengough, M.A., of Liverpool University. The First Report was presented at the London meeting of the Institute in January, 1911, and consisted of a general review of the then available world-knowledge of the subject of the corrosion of non-ferrous metals, both in its practical and scientific aspects. Having reviewed the field open for research, Dr. Bengough proceeded to experimental work at Liverpool with the aid of a specially constructed condenser, built as a result of funds provided by generous donors.

For the purposes of the Report, inquiry forms were widely circulated by the Institute amongst users of condenser tubes. Twenty of the most complete have been selected and the information contained has been tabulated. Important points brought out are :—(1) The erratic nature of the trouble. Different users give as the normal life of a tube periods varying from 4 to 25 years. (2) The nature of the deterioration is in the great majority of cases dezincification, which results finally in a rotten and pitted tube. This type of corrosion is called "selective corrosion." Occasionally tubes fail by localised "complete corrosion," *i.e.*, by the rapid removal of both Cu and Zn over certain areas. (3) It is not possible to correlate the failure of tubes with the presence, or nature, of the electric lighting system. (4) There is no obvious connection between any definite locality in a condenser and the frequency of dezincification.

In the almost entire absence of experimental work showing how the speed and type of corrosion vary as the conditions vary, it was considered advisable to carry out a detailed laboratory investigation into the matter. The results are given in three sections.

Section I.

Laboratory Investigation on the standard tubes of the Corrosion Committee.

Composition.

	1 70 : 30 Brass.	2. 70 : 28 : 2 (Pb.) Special Brass.	3. 61 : 39 Muntz Metal.	4. 70 : 29 : 1 Admiralty Brass.
Copper	70.21	69.94	60.90	71.18
Zinc	29.17	27.60	38.21	27.28
Tin	—	—	—	1.07
Lead	0.27	2.08	0.46	0.28
Iron	0.27	0.28	0.33	0.21
	99.92	99.90	99.90	100.02

Summary of Results of Experiments carried out at 20 deg. C.

(1) Corrosion at this temperature is always of the approximately complete type and is slow and uniform.

(2) Carbon (in the form of coal, graphite and coke), sand, copper, and a number of other bodies have, *per se*, little or no effect on the speed or type of corrosion. They do not give rise to any appreciable electro-chemical action.

(3) Certain basic salts of zinc and ferric oxide appear to have some slight accelerating effect, but it is too small to be practically important.

(4) An increase in the concentration of the sea-water increases the speed of corrosion; a decrease in concentration decreases it. The type of corrosion is unaffected (but see below).

(5) The order in which tubes resist loss of weight is as follows :—(1) Muntz metal. (Loses least weight.) (2) 70 : 28 : 2 alloy. (3) 70 : 30 brass. (4) Admiralty metal.

(6) An increase in the speed of the water increases the amount of corrosion.

(7) Jelly tests have given inconclusive results.

(8) "Selective corrosion" could not be obtained at 20 deg. C., except by the employment of free acid, or by the use of diluted seawater for very long periods of time.

(9) A detailed account is given of the nature of the reaction which takes place during the process of corrosion.

(10) No evidence is forthcoming that "flaws" and "spills" have any influence on corrosion at the ordinary temperature.

Results of Experiments at 40 deg.

(1) Corrosion at this temperature is of a distinctly "selective" type, *i.e.*, the zinc is removed from the metal in larger amount, proportionately, than the copper.

(2) This action is by no means uniform but begins at certain points and spreads outwards. The causes which determine the distribution of these points is discussed in detail. The action is inherent in alloys of the types considered, given the presence of sea-water and suitable temperature conditions.

(3) The order of resistance to "selective corrosion" at this temperature is :—(1) 70 : 28 : 2 alloy (most resistant). (2) Admiralty alloy. (3) 70 : 30. (4) Muntz metal.

(4) Sea-water diluted with its own volume of distilled water exerts a greater selective corrosion effect than ordinary sea-water. Concentrated sea-water stimulates complete corrosion, but represses selective corrosion.

(5) The influence of carbon particles, etc., was no greater than at the ordinary temperature.

* Other members of the Corrosion Committee are :—Mr. L. Archbutt, Dr. G. D. Bengough, M.A., Prof. H. C. H. Carpenter, M.A., Ph.D., Eng. Rear-Ad. G. G. Goodwin, R.N., Prof. A. K. Huntington, A.R.S.M., Mr. J. T. Milton, Mr. A. Philip, B.Sc., Sir W. E. Smith, C.B., Mr. L. Sumner, M.Sc., and Prof. T. Turner, M.Sc.

† See IRON AND COAL TRADES REVIEW, January 20, 1911.

(6) The presence of zinc oxychloride on a tube gives rise to severe dezincification.

Enquiries have shown that it is highly probable that temperatures of 50 deg. C. and upwards are frequently attained in condensers. Consequently, a series of experiments at 50 deg. C. were conducted, mainly on 70 : 30 brass and Admiralty metal.

Results of Experiments at 50 deg. C.

(1) Corrosion is of the selective type, and is concentrated almost entirely on the zinc. Mere traces of copper only were removed from the tubes, except in the case of the Admiralty tube.

(2) The action is severely localised.

(3) The order of resistance to selective corrosion is :—(1) Admiralty metal (most resistant). (2) Muntz metal. (3) 70 : 30 brass. The last two tubes showed signs of dezincification in seven days. No signs of dezincification could be detected in the Admiralty metal in four weeks.

(4) The total weight of metal lost is lower at 50 deg. than at the ordinary temperature for equal lengths of time. If the water be aerated the weight lost is enormously increased, and is greater than at the ordinary temperature.

(5) The effect of particles is the same as at the lower temperatures.

(6) Dilute sea-water (as above) and concentrated sea-water act as at 40 deg. C.

Section II.

Full details of the work carried out with the experimental condenser plant are given, and a comparison is made between the conditions obtaining in it and in an ordinary marine condenser. Three tubes of each of the standard compositions have been withdrawn and examined. The tubes themselves and the scale have been subjected to detailed examination. All the tubes show signs of dezincification with the exception of one of the Admiralty tubes, and one of Muntz's special brass. The extent and distribution of the areas of dezincification are considered in the light of the laboratory work. The agreement in the results obtained by the two methods of work is very striking.

Section III.

Some preliminary experiments on the nature and mode of action of electro-chemical protection methods are described, and the important part played by calcium carbonate scale is emphasised. A general discussion of the bearing of the whole of the experimental results upon the practical problem under the varying conditions met with in practice is appended, and some suggestions are made as to possible methods of preventing corrosion.

The Intercrystalline Cohesion of Metals. (Second Paper.)

This Paper, by Dr. W. Rosenhain, F.R.S., and Mr. D. Ewen, M.Sc., is a continuation of a research undertaken in order to test by experiment the theory that the crystals of a metal are held or "cemented" together by thin films of the same metal in the amorphous or undercooled liquid condition. In their previous Paper the authors obtained evidence in favour of this theory from the behaviour of metals when heated in a high vacuum. Since then, the theory has received further support from the researches of Rosenhain and Humfrey on the tenacity and fracture of mild steel at high temperatures (Iron and Steel Inst., May 1913). There it was shown that at high temperatures the type of deformation and fracture obtained by any but very rapid strains was entirely different from the type found at low temperatures. In the latter type both deformation and fracture occur principally within the crystals, while the boundaries act as stiffening and strengthening ribs; at high temperatures, on the other hand, the crystals remain almost undeformed, while movement and ultimate fracture occur principally in the intercrystalline boundaries. Detailed consideration of the observed facts shows that they can be readily explained by the amorphous cement theory—the cement being strong and hard at low temperatures but, like all very viscous fluids, becoming soft and mobile at high temperatures. An extension of this idea shows that at a sufficiently high temperature in all pure metals the "cement" must become so fluid as to possess no appreciate strength, while the crystals still retain a definite degree of strength and hardness. It follows that at such temperatures the crystals even of the most ductile metals should be capable of being pulled apart without undergoing deformation, and the metal should exhibit extreme inter-crystal brittleness. This has been experimentally verified in the case of lead, tin, aluminium, and bismuth, photographs of the strikingly inter-crystalline fractures thus obtained being given in the Paper —the brittle fracture of lead at 323 deg. C. (melting point 327 deg. C.), having an appearance like that of a brittle casting. These experiments show that the well-known brittleness of metals near their melting-points is due to loosening of intercrystalline cohesion as indicated by the amorphous cement theory. The author deals with the suggestion that impurities concentrated in the crystal boundaries may affect these results, and show that this objection cannot apply to their experiments; they strengthen this view by showing that a pure eutectic alloy (that of lead and tin) exhibits analogous phenomena.

The Micro-Chemistry of Corrosion. Part I. Some Copper-Zinc Alloys.

In this Paper, by Dr. Cecil H. Desch, D.Sc., Ph.D., and Mr. Samuel Whyte, experiments are described in which uniform areas of various alloys are corroded for a definite time under the influence of an electric current. The material dissolved by the electrolyte is analysed, as well as the adherent metallic deposit. The surface of the alloy is also examined microscopically before and after the removal of this deposit. The alloys used in the first series of experiments are beta alloys of copper and zinc with and without the addition of tin or iron. Quenching from above the transformation point (470 deg.) increases the corrosion, although the action is slightly retarded at first. Iron hastens corrosion, whilst tin retards it. The influence of the latter element, however, is chiefly mechanical, by means of the formation of a tough adherent layer of basic salts, which serves as a protective coating. The microscopical appearance of the corroded surfaces is characteristic.

The Specific Volume and Constitution of Alloys.

Dr. Guertler's Paper on this subject is of a theoretical character and follows up a previous communication of his to the Institute of Metals in which he discussed the connection between the electric conductivity of alloys and their constitution.

A Study of Volume Changes in Alloys.

The results of the research, which are embodied in this Paper by Mr. J. H. Chamberlain, M.Sc., show that volume changes obtained in alloys are of both theoretical and practical importance. Their relation to the crystallisation intervals as plotted from the equilibrium diagram was clearly shown in

the copper-aluminium series. The force producing the expansions, obtained in castings during solidification, was in the case of a copper-tin alloy (90 per cent. copper), a copper-zinc alloy (15 per cent. zinc), and pure aluminium shown to be of considerable magnitude. With the copper-tin alloys, and pure aluminium castings, the temperature at which the metal is poured appears to have some effect on the expansions observed. The extraordinary large and quiet expansions peculiar to the copper-zinc alloy, in the neighbourhood of 15 per cent. copper, are always preceded by an arrest. On slowly heating up bars of a copper-tin alloy (90 per cent. copper), a copper-zinc alloy (15 per cent. copper) and pure aluminium in the electric furnace, contractions in the length of the bar were obtained in each case. On allowing the bar of the copper-zinc alloy to cool slowly, a most extraordinary expansion was obtained, far larger than that yielded on casting, and on repeating the heating-up and cooling-down operations five times the bar was found to have grown in length from 10 in. to 11½ in., and also to have increased in sectional area.

The Influence of Phosphorus on some Copper-Aluminium Alloys.

Some mechanical and physical properties of a number of copper-aluminium alloys with 5 or 10 per cent. of aluminium and varying amounts of phosphorus have been investigated, and the results embodied in this Paper by Professor A. A. Read, M.Met. The effect of small quantities of phosphorus, up to 0.2 per cent., on the 5 per cent. aluminium alloy is to diminish its capacity for hot rolling, though its behaviour in cold-drawing is improved. The yield point and maximum stress of the annealed metal are slightly raised, and the reduction of area is lowered without however affecting the elongation. The resistance to alternating stress is slightly increased. Tested in the form of chill castings with varying amounts of phosphorus, up to 1 per cent. the yield point was found to rise considerably; the ultimate stress attained a maximum at 0.[illegible] per cent., but the elongation and reduction of area fell rapidly. Phosphorus has a hardening effect above 0.25 per cent. The 10 per cent. aluminium alloy suffers considerable loss in its mechanical properties by annealing; 0.1 per cent. of phosphorus slightly improves the character of the annealed metal. There is, however, no improvement in the properties of the cold-drawn metal of the chill castings. Phosphorus cannot be added to this metal in greater amount than about 0.2 per cent. on account of the formation of aluminium phosphide which gives off phosphine on exposure to the moisture of the atmosphere. Phosphorus lowers the melting point and conductivity for electricity of both the alloys. When present in the rolled metal it reduces the loss due to corrosion of these alloys by sea-water.

A Method of Improving the Quality of Arsenical Copper.

In this Paper Mr. F. Johnson, M.Sc., records the results of an investigation of the properties of specially alloyed arsenical copper with a view to proving its suitability for use in locomotive stay-rods, wire for rivet manufacture, and any material required to have specially high malleability, ductility and toughness combined with tensile strength and resistance to reducing gases at high temperatures.

The Copper Rich Kalchoids.

The author of this Paper, Professor Samuel L. Hoyt, explains that the unusual word used in its title is employed to designate the ternary alloys of copper, tin and zinc as was first suggested by Thurston. The Paper gives the results of a prolonged research into the constitution of certain kalchoids rich in copper, the percentage of zinc and of tin never exceeding 50 and 30 respectively. From his microscopical analyses—and the Paper is very liberally illustrated with upwards of 40 photomicrographs in plate form—Professor Hoyt draws the general conclusion that the ternary alloys of copper-tin-zinc, up to the above-mentioned percentages, behave similarly to the binary alloys of copper-tin and copper-zinc. The Paper has been prepared by a Professor in the American University of Minnesota, who made his investigations in the Charlottenburg-Berlin School of Technology.

The Determination of Oxygen in Copper and Brass.

The author of this Paper, Mr. T. West, M.Sc., has worked out a method for the estimation of oxygen in copper and brass using carbon-monoxide as the reducing agent. In the first instance the conditions for estimating oxygen in copper were determined by comparative tests with the customary method of reducing with hydrogen. A temperature of about 900 deg. C. was found to be sufficient, the time varying between two and three hours. Since any oxygen in brass probably exists in the form of zinc oxide, a number of experiments were next carried out under varied conditions to ascertain how far the resulting carbon dioxide could be relied upon as a test for zinc oxide. It was found that, provided the temperature reached 1,050 deg. and the gas current was sufficiently rapid, the amount of carbon dioxide formed corresponded closely to the actual weight of zinc oxide taken. Finally, tests were made on samples of pure brass and these showed that ordinary brasses of good quality contain on an average about 0.002 to 0.003 per cent. of oxygen. Tests were also carried out on a condenser-tube brass containing about 2 per cent. of tin and also on German silver. In these cases a rather surprising result was obtained, since a deposit of carbon was found adhering to the metallic surface after cooling down in an atmosphere of carbon monoxide. The method therefore can only be applied to the estimation of oxygen in brasses containing copper and zinc (with the ordinary amounts of commercial impurities) and not to spiral brasses containing tin or nickel, on account of their decomposing action on carbon monoxide.

Metallurgical Researches on Egyptian Metal Antiqu ties.

Mr. H. Garland, in this Paper, describes his investigations into the crystal structure of Egyptian metal objects, all more than 2,000 years old, made either of bronze or copper. He gives the interesting case of a bronze knife, 3,500 years old, in which the original cored structure has endured until the present day, and is still perfectly stable at atmospheric temperatures. The view is held that the knife was hammered cold and so the best cutting edge was obtained. The crystal grains are very small, there having been apparently no crystal growth during the ages that have passed since the metal was first worked. This shows either that recrystallisation does not take place at ordinary temperatures, or, if it does, then many times 3,500 years is required to effect the change. Mr. Garland gives other cases of the persistence of the "cast cored" structure in antique alloys, illustrating his views by means of photomicrographs of a small bronze chisel, such as would be used by a jeweller in ancient Egypt, a copper arrow tip, and of a bronze spatula.

Moulding Hydraulic Pipes in Dry Sand, Vertically Cast.

By Sidney G. Smith

(*All rights reserved.*)

In making hydraulic pipes, which may vary from one to two inches in thickness, and which have to stand a pressure test of from 1,000 to 3,000 lbs., undoubtedly, with a suitable iron, a vertically cast dried mould will give the best results, as regards both soundness and economy. In the following method, if the tackle is properly made, waste work is practically nil, and satisfaction in the quality of work is ensured, which is saying much in these days of exacting tests

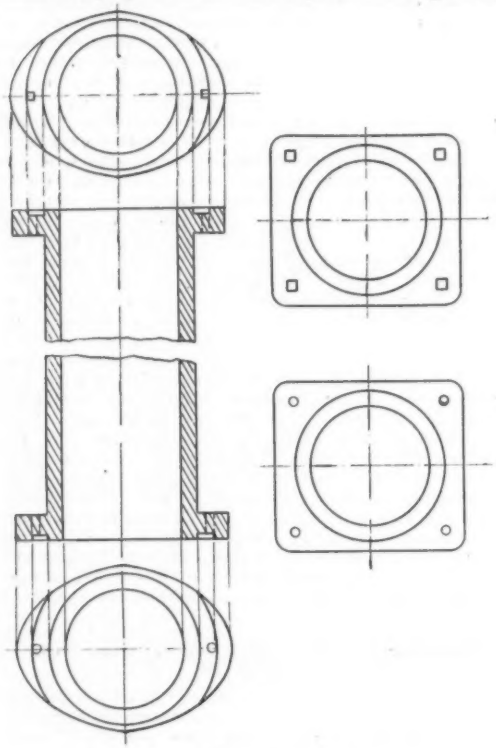


Fig. 1.—Sketch of Pipe.

and inspection. Fig. 1 gives a sketch of a pipe which may have either oval, square or rectangular flanges, which is unimportant since the top end of box and the bottom box can be made to suit either. No dimensions are given, as the method of moulding is applicable to pipes from 2-in. diameter upwards, and 9 ft. or 10 ft. long.

Fig. 2 shows the complete assembled mould when ready for pouring. Fig. 3 shows boxes J and body pattern H on the ramming plate A; also top-flange pattern E and head pattern F in position when rammed. Of course, the latter two patterns and head box C are not in that position when the body is rammed.

When the ramming plate A is levelled the box J is lowered on to plate A, in which guide pins are provided to receive box J. After being rammed to the top shoulder of the body pattern, the flange pattern E, which has a guide corresponding on the body pattern, is passed over the top and bedded. After ramming a parting-sand joint is made, and the head box C is put on; the head pattern F, with cake print, is passed over the body pattern, and the box rammed. After drawing the head pattern the box is parted, the top flange drawn, also the body pattern. The mould is then lifted from the ramming plate and blacked, box C replaced, and the mould put on the

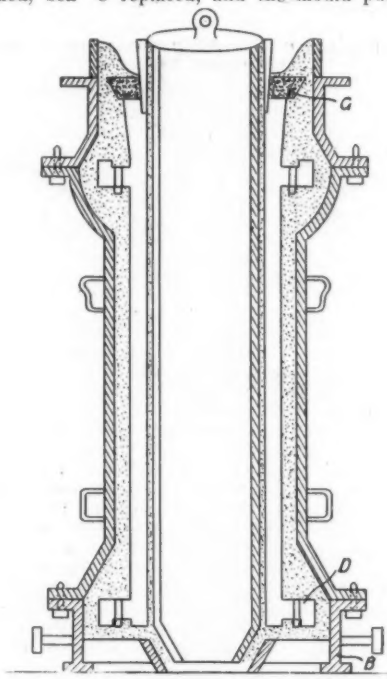


Fig. 2.—Section of Assembled Mould and Tackle.

drying plate and dried by gas without being taken out of the pit, the pit being large enough to hold several boxes. The ramming is done at one end of the drying and casting pit, for which ample room should be provided.

Fig. 4 shows section and plan of ramming plate A. Fig. 5 shows the bottom flange box B. This box is rammed on a turning-over board which forms the bottom flange D and the seat for the body core. The bottom flange boxes are stoved with the main body cores. Fig. 6 shows the head box C; Fig. 7 the bottom-flange pattern D; Fig. 8 the top-flange pattern E; Fig. 9 the head pattern with cake print F; and Fig. 10 the sand runner cake G. These cakes are made in an iron box, with milled sand. When dried the runner gates are filed out to correspond with the diameter and thickness.

For pressure pipes the quality, grade and mixture of iron is important and more especially for those cast horizontally, such as bends, branches and elbows. The iron should be close in fracture, hard and tough. A suitable grade would be a No. 5. The approximate analysis would be, in the pig:—C. C., 0.65 per cent.; G. C., 2.50 per cent.; Si., 1.70 per cent.; Mn., 0.55 per cent.; P., 1.25 per cent.; S., 0.06 per cent.—75 per cent. of the above pig; 25 per cent. of clean, close-grained scrap.

The above analysis is based upon ordinary Cleveland or Derbyshire foundry iron, and will be found quite suitable, and will give satisfaction for the work in question.

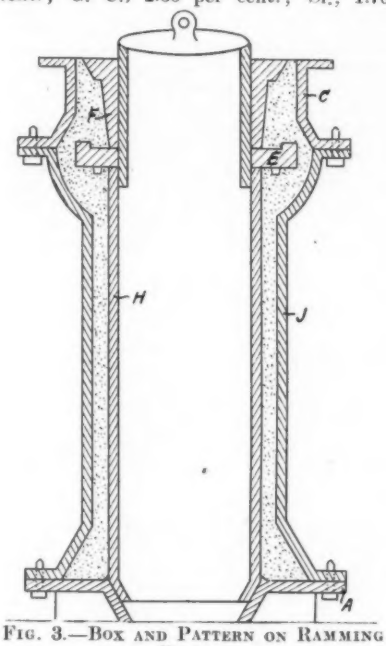


FIG. 3.—BOX AND PATTERN ON RAMMING PLATE.

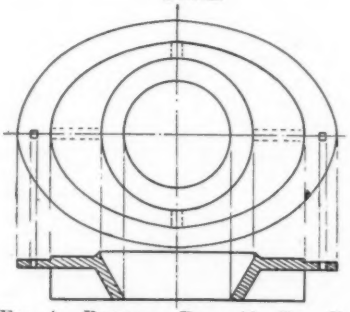


FIG. 4.—RAMMING PLATE (A, FIG. 3).

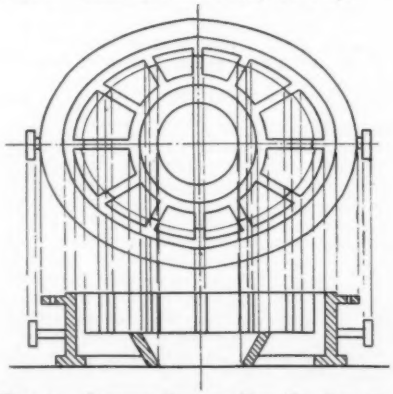


FIG. 5.—BOTTOM FLANGE BOX (B, FIG. 2).

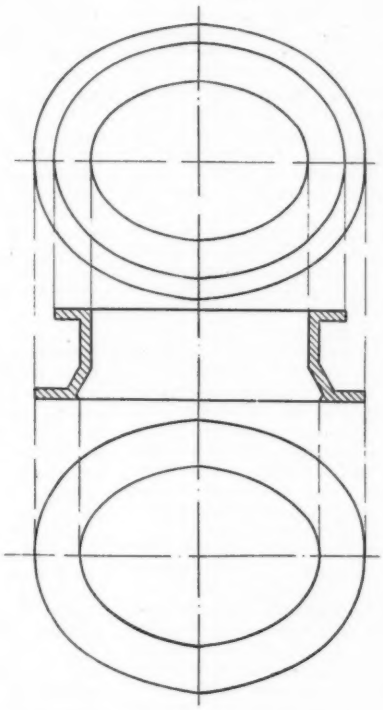


FIG. 6.—TOP HEAD BOX (C, FIG. 3).

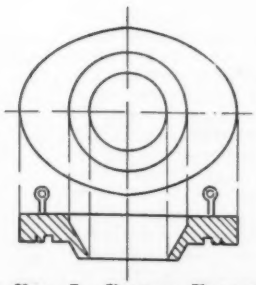


FIG. 7.—BOTTOM FLANGE PATTERN (D, FIG. 2).

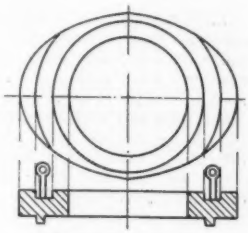


FIG. 8.—TOP FLANGE PATTERN (E, FIG. 2).

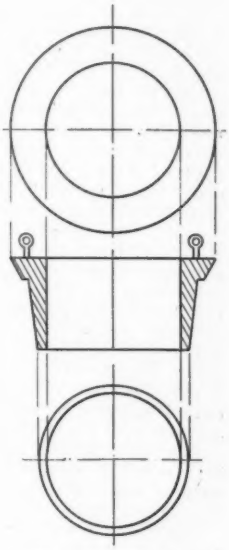


FIG. 9.—HEAD AND RUNNER-CAKE PATTERN (F, FIG. 3).

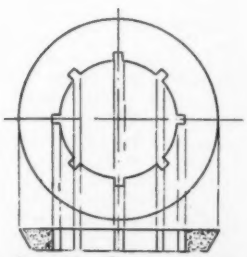


FIG. 10.—RUNNER CAKE (G, FIG. 2).

Steel in the Cupola.*

By David McLain.

Thirty-five to forty years ago, I remember, when the foreman threw some steel shavings or turnings into a ladle of iron, the metal was called semi-steel if the castings were good; if not, it was called a "bastard metal." Other users poured pig-iron around steel or wrought scrap and recharged this in the cupola, claiming this to be the only way to melt steel scrap. Only recently I observed a melter throw pig-iron and steel scrap on the last of the heat, which was run into pigs and remelted. When I spoke to the foreman, he asserted this was the proper plan to follow. Imagine the extra cost.

The men who noted the good effects derived by adding some steel to the iron in the ladle, tried later to melt steel in the cupola, and, of course, the fellow who was of an investigating turn of mind, by continual application, was soon able to melt as much as 30 per cent. in the mixture, which was generally used to pour heavy castings.

It must be remembered that 90 per cent. of the so-called "semi-steel" made in those days, which contained but a small percentage of steel, was either too hard or full of blow holes, and the castings in many instances resembled poor crucible steel castings. Both crucible and Bessemer steel castings were made in the plant where I was employed, and, of course, metal for the converter was melted in a cupola. As the gates, risers and defective steel castings were quite an item, it was desirable for economical reasons to melt as much as possible.

I may here remark that in later years I helped one converter plant to melt at times 50 per cent. steel. Previous to my engagement, they had been selling steel scrap for half its value, but later they bought steel scrap in truckloads to melt in their cupola.

Being originally a steel maker, and knowing the importance of having all material analysed, on my entry into the iron foundry I was rather surprised to learn that very few paid any attention to analysis. Some founders labour under the delusion that it is necessary to have a chemist in their plant. This is not a fact. Many firms do not spend more than 35s. to 40s. a month for analytical work—some have never spent a shilling for this purpose, but work to the furnace reports.

Starting in the crucible steel foundry, I was familiar with the melting of steel in the old coke furnaces, which were replaced by regenerative furnaces. I had charge of one of the first Bessemer converters used for making steel castings exclusively, and later a 20-ton open-hearth furnace; I thus had the advantage over most iron founders, in knowing steel and the laws governing the melting of the same. But all I had ever seen, heard, or read about the use of steel in cupola mixtures was directly connected with large and heavy work. I had never met a man up to the time I began experimenting, who had claimed to be able to use steel scrap for light castings.

In 1900, when superintendent of a plant where certain small cylinder-head castings were giving a loss as high as 60 per cent., I called in "semi-steel" experts who were given full charge of the cupola for ten weeks; but as they had never handled such light castings before, they failed, although I believe they had been very successful on heavy work in other plants. Defective castings, made by the experts, on being analysed, showed very low carbon, and it was apparent that high carbon was necessary for these light castings. I then experimented by adding ferro-manganese to the cupola charge, but owing to previous experience in melting steel and knowledge of the purifying and strengthening qualities of manganese, I began working along different lines from any other foundryman of that time. The steel and manganese did exactly what they were calculated to do, namely: increase the total carbon, reducing sulphur, and allowing the lower silicon mixture to be used, thereby giving a very close-grained metal, free from segregation and blow holes.

The effect in the machine shop of this solution to the problem was remarkable. The sections were as light as $\frac{5}{16}$ in., 30 to 50 per cent. steel being used; yet the castings got through the machining to the tests with a loss of 2 to 3 per cent.—in some instances a few with less loss. It truly was semi-steel, containing 30 to 50 per cent. steel. Quite often we had men sledge these light cylinder heads with a thirty-six pound hammer; but the metal would not begin to crack until it had sunk in considerably, similar to steel.

On one occasion, having too much "semi-steel" in the ladle, I poured a mould which had been made for a steel magnet frame, and the next day, when it was broken, the grain of the metal looked like soft steel. Immediately I called our electrical expert's attention to it, and while he was impressed with my enthisiasm, I kept hammering at him for months before he would give me an order for a semi-steel magnet frame. After the test, however, he became as enthusiastic as I was. Later he wrote:—"In the design of direct-current generators and motors, I found it possible to work with semi-steel both in density and cross section just halfway between steel and cast iron. In other words, a cast-iron magnet frame that would require 100 sq. ins. of metal would require only 75 of semi-steel and 50 of steel."

In 1903 a leading metallurgist wrote:—"You have hit on a point which bears out all my years of contention on the oxidation of iron in the melting process. Where you see such high percentage of steel you necessarily have a higher temperature in the melt and with this higher temperature, any addition of manganese means a reaction with the oxygen present from the unavoidable burning of the steel in the charges. In ordinary cast iron this cannot take place, as the temperature is not high enough, hence manganese is not a good thing there. I presume that you must lose quite a lot of manganese by this process, which shows that it is effective and does the work it is put in for."

Scientific melting in a cupola is considered a joke by many foundrymen. In this connection it is interesting to recall the experience of two foundry-owners in the same city, who decided to use steel scrap. Number one was a strictly jobbing shop, while number two was an adjunct to a large machine and structural-steel shop, which also made jobbing castings. The first one became a large user of steel scrap and soon obtained orders for castings which had been made by number two. Number two investigated and learned that the steel scrap he was selling to a dealer for 29s. per ton, was being resold to number one for 46s. per ton, and the latter was using it in his cupola, replacing a proportion of pig which cost

* President, McLain's System, Milwaukee, Wisconsin, U.S.A.

him 70s. a ton; so everybody was happy—except number two, who had failed in his use of steel scrap, because he thought there was nothing new to learn about melting in a cupola.

When you have learned good cupola practice, you will note that steel scrap melts first. In making metal for light castings, steel and other scrap with pig is placed on the bed, making as many charges of semi-steel as desired, following with the usual mixtures. By this method there is no "bunging up" of your cupola, and no harmful effects to later charges of regular mixtures.

Technical men still claim that there is no such metal as semi-steel—they say it is a misnomer. But we practical fellows are satisfied to call it such. When it is known that we use from 30 to 50 per cent. steel in the charge, and thereby increase the tensile strength ten thousand to fifteen thousand pounds per sq. in., isn't it semi-steel?

If metal for dies, anvil blocks or castings of like character is desired, semi-steel may be made on the latter part of heat. No more coke is necessary to melt it than grey iron, but it is best to use a heavier split of coke between the last charge of semi-steel and the following charge to prevent the latter from melting through.

The claim has been made that steel will not mix with iron, but the best evidence that steel will mix with iron is proven by the fact that light cylinder-head castings containing 30 per cent. steel are being run through milling machines in thousand lots with less than 2 per cent. loss.

Steel scrap should not be used in the ladle, as many imperfections are traceable to this practice. Steel should be charged in the cupola, then all gases will be liberated in the cupola, *not* in the castings.

While the addition of steel to any mixture improves the quality, the following are a few of the castings in which 10 to 50 per cent. steel scrap may be used:—Acid castings, agricultural castings, air cylinders, ammonia fittings, anvil blocks, automobile cylinders, bed plates, car wheels, crane wheels, cross heads, crusher jaws, dies, engine castings, fire backs, furnace castings, gas cylinders, gears, gear blanks, grate bars, hammer heads, jig castings, lathe beds, locomotive parts, machinery castings, marine cylinders, mine wheels, mould boards, pillow blocks, pistons, plough points, propellers, pulleys, pumps, riveters, rolls, rolling-mill castings, valves, water cylinders, and all kinds of castings that must stand inspection for hydraulic or other tests, or where high transverse or tensile strength is desired.

Steel scrap in suitable cupola mixtures produces a fine chill, and the largest car-wheel shops have reduced the percentage of charcoal iron to the minimum by the use of steel scrap, but this is only possible when the man who has charge of the mixtures understands the laws governing the melting of steel in the cupola and is familiar with good cupola practice.

In connection with the subject of technical education, the Hull Iron Trades Employers' Association have, in compliance with the resolution carried at a meeting on June 3 last, held a further meeting of the shipbuilding, engineering and allied trades, when the position was discussed, and the following gentlemen were elected to act on the advisory committee, namely:—Mr. James Brackenbury, of Amos & Smith, Limited; Mr. James Downs, of Rose, Downs & Thompson, Limited; Mr. A. H. Tyacke, of Earle's Shipbuilding & Engineering Company, Limited; Mr. John Watson, of the St. Andrew's Engineering, etc., Company, Limited; and Mr. Frank Burrell, of Shipham & Company, Limited. The first three represent the federated firms, and the remaining two the non-federated firms.

Steel Pipes versus Cast-Iron Pipes.

At the present time some engineers are being tempted to put down steel pipes instead of cast-iron, owing to the saving in capital expenditure, without thoroughly looking into and comparing the risks attached to steel, and the ultimate cost of same. It is most important that all the facts obtainable should be considered before arriving at a decision as to which material to adopt. Owing to the thinness of the steel pipes, and their liability to corrosion, the life of a steel main is entirely dependent upon its protective covering, and as corrosion takes place most rapidly where the steel main rests upon the ground, and where it is practically impossible to re-coat the pipes, it is obvious that if corrosion once commences, nothing can stop it. Engineers who have had experience with steel mains are mostly agreed that its use is limited to (1) very high pressures, (2) temporary purposes, (3) cases where it is physically impossible to put down cast iron, and (4) cases where the initial cost of cast iron is the most important consideration.

At Port Elizabeth, recently, in the course of a Town Council discussion on the waterworks, it was stated that seven million gallons of water were being lost monthly between the waterworks and the town, owing to leakage in the pipes. When the new waterworks were constructed some six or seven years ago, some thousands of pounds in the cost of transport were saved by laying down steel mains instead of cast iron. Washaways, over a year ago, however, revealed the fact that this steel pipe was not wearing at all well; in fact, at several points it was discovered to be completely rusted through. The defective pipes were replaced, but it now transpires that practically the whole main, covering a distance of over 25 miles, is affected and will have to be replaced.

There are many other steel and wrought-iron failures. The steel main over the Tay Bridge was laid in 1891 under the most favourable conditions, being protected from all climatic conditions by being enclosed in a wooden box. The main has been kept carefully coated with bitumen at a serious annual cost, but in spite of this it was found to be defective in 1910. The steel main is being replaced by one of cast iron. The Coolgardie main of 350 miles of 30-in. steel pipe, was laid in 1903, and found in 1906 to be defective.

There are many other failures, amongst which are:—Rochester (U.S.A.), 26 miles of 38-in. pipes, defective in four years; San Bernada (U.S.A.), defective in three years; Lockport (U.S.A.), defective in two years; Bombay, Port Trust, defective in four and a-half years; and others. Most of these and many others have been replaced with cast-iron after a very few years. As against these steel and wrought-iron failures, there is not a single known case of a failure in cast iron, with the exception of one or two isolated instances where the ground was such that possibly no material would have had a long life. The life of cast-iron mains is known to be over 100 years, as instance the following:—Versailles, 249 years; Weilburg, 210 years; Claremont-Ferrand, 165 years; Glasgow, over 100 years. The Vehar mains in Bombay after 55 years' service are now being lifted and relaid within the city.

Messrs. Kelvin & James White, Limited, of 18, Cambridge Street, Glasgow, inform us that to avoid the confusion which has frequently arisen between their name and that of another firm of instrument makers, they will in future trade under the title of Kelvin, Bottomley & Baird, Limited.

Foundry Plant and Equipment.

An Improved Converter to Facilitate Repairs.

By A. F. S. Blackwood.*

Since the introduction of small converters for the manufacture of light and intricate steel castings, such as used in the motor-car and allied trades, it has been found in practice that, owing to the high temperature at which the metal has to be poured in order to run the thin sections called for, the wear on the lining is most severe, and it is impossible with the ordinary converter to get the maximum output and run continuously every day without having to shut down for repairs. The cost of repairs is very high, due largely to the time absorbed by the cooling process. Many efforts have been made to reduce this time, one method being to blow cold air into converter for about four hours after the last blow. Another

Fig. 1.—Repairing Lower Section.

method, now extensively followed, is to make one repair weekly, and blow continuously all the week on this repair. Both methods, however, are disadvantageous in modern practice.

To overcome the difficulty, the writer has designed a two-piece converter which eliminates this period of inactivity and renders the operation continuous. It requires no mechanism for effecting the separation of the parts other than an overhead or jib crane.

The greatest wear on the lining of a side-blown converter is on a plane immediately above the tuyeres, and with this point in view the converter under notice is divided into two halves through this plane, which is situated just above the trunnions. The bottom half carries the trunnions, which are cast with the ring that encircles the bottom half of the converter shell; the top of this is the dividing line of the two parts, and carries the top part of the converter; these are bolted together and riveted to the shell. On the ring immediately over the blast box is bolted a heavy steel plate which pre-

Fig. 2.—Auxiliary Trunnions Supporting Top Section.

vents the slag and metal from clogging up the swing door on the blast box while blowing, and to this plate is attached a swinging cast-iron frame which carries

Fig. 3.—Placing Top Half on Lower.

the oil burners, the latter fitting into the tuyeres for heating the converter before blowing. On the top flange of the ring are six shackles, and when the top

* Vice-President of the Michigan Steel Casting Co., Detroit, U.S.A.

is lowered in place these shackles swing into slots in brackets on the top of the lower half of the vessel; a key is driven through the hole in the head of each shackle, thereby firmly securing both parts together. On the top half of the converter are four eye brackets through which are passed the chain hooks for lowering and lifting it. There are also two trunnions bolted on this part in line with the trunnions on the bottom half, so that when the top half is being cooled for repairs it may be set on a special frame. This frame, having two journals, allows this top part to be swung round in any direction convenient for repairing.

Immediately after the last blow, the crane hooks are placed in the eye brackets, and the top part lifted off and placed on the frame for cooling. In about two hours' time repairing may proceed, as it has been found in practice that the hotter the lining is when being patched the better it resists high temperatures. After the removal of the top half, the bottom half is brought into a horizontal position, and the condition of the tuyeres and lining observed, enabling the attendant to ascertain the condition of the converter only a few minutes after the last blow. As the converter is repaired every morning the dimension lines are kept well defined, and no forms, boards or special plates need be used, nor is it necessary to put in new tuyeres, as they are rammed up to the proper length every morning. The lining in the bottom half is rammed up to within 1 in. of the joint line, leaving a space for the refractory material used in making the joint.

When the repairs are completed, the top half is lifted by a crane, and lowered on to the bottom half, the shackles are fixed into the slots, the keys tightened, and the converter turned through an angle of 75 degs. and fired up. The total time occupied in repairing, closing, and heating is about three hours.

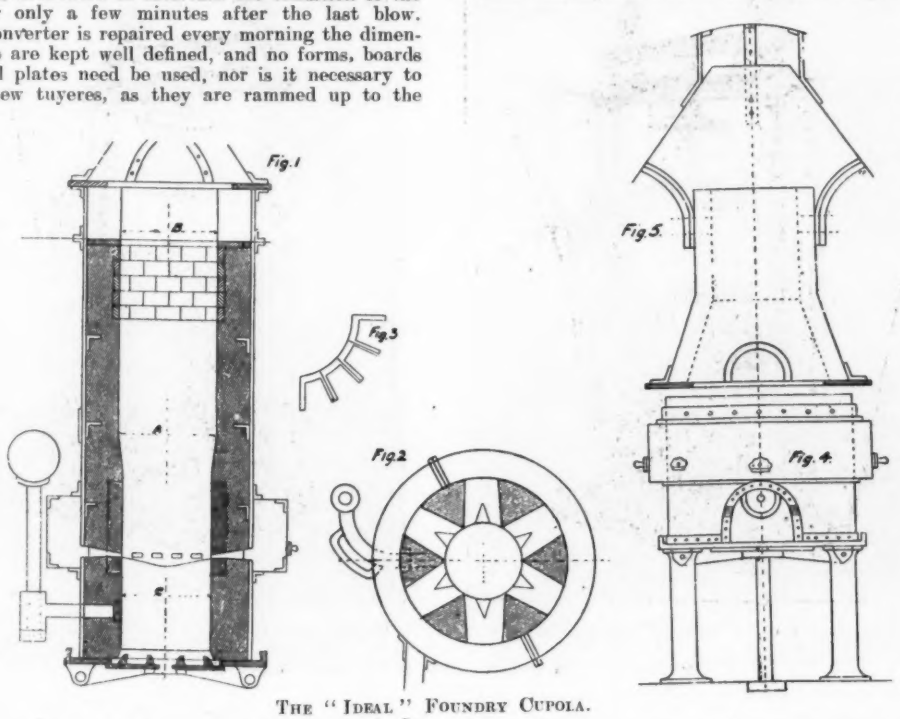
In the illustrations, Fig. 1 shows the bottom half being repaired, and demonstrates the accessibility of the tuyeres. Fig. 2 shows the auxiliary trunnions for supporting the top section. Fig. 3 shows the method of replacing the top half and securing the sections together with shackles.

At the Michigan Steel Casting Company's plant there are three of these converters working, two of which have been in continuous operation for over two years, giving an average minimum output of 12 tons per day each, not a day having been lost for repairs. The average time for blowing one ton is 11 minutes with the blast going into the converter at atmospheric temperature. The steel is poured direct from the converter into small hand ladles, and by the aid of a special core placed in the mouth of the converter slag is prevented from mixing with the metal entering the ladle.

This converter is manufactured by the Tropenas Converter Company, New York.

The "Ideal" Cupola Furnace.*

The new "Ideal" cupola furnace of the Cie. Générale pour l'Equipment de Fonderies, Brussels, has been designed for the purpose of melting pig-iron with a small consumption of fuel and of motive power for the blast, the construction being made as simple as possible, and the upkeep for lining reduced to a minimum.



THE "IDEAL" FOUNDRY CUPOLA.

In the drawing, Fig. 1 is a vertical section through the centre of the furnace; Fig. 2 a transverse section through the medium plane of the tuyeres; Fig. 3 a horizontal section through a portion of the cast-iron blocks protecting the throat of the furnace against wear and distortion; Fig. 4 a rear elevation showing the general arrangement of the cupola, the relative position of the circular main for distributing the blast among the twin tuyeres, the position of the hole for workng the slag, and the special device for automatically discharging the furnace at the bottom when the charge is finished; and Fig. 5 an elevation of the

* "Fer et Acier."

separate chimney stack with protecting hood and spark arrester.

The iron-plate outer casing is made in two sections, of equal or unequal height, a large socket ring being riveted on the top of the lower section so as to form a support for the upper one. This arrangement facilitates transport and mounting and allows free expansion of the parts. Angle-iron rings, 4 by 4 in., are riveted inside the casing, at intervals of 40 in., to support the firebrick lining, and enable this latter to be replaced in sections as required. The circular main for distributing the blast is made in two parts bolted together so as to hold, friction-tight, on the casing, and to be easily taken apart for repairs or cleaning. This main is of large dimensions, so as to maintain the initial pressure of the blast and ensure uniform distribution among the tuyeres. The connection with the main supply pipe is of large rectangular section, arranged so as to impart a gyratory motion to the blast, and fitted with a valve so that the blast can be shut off and diverted to another furnace if necessary.

Fig. 2 shows the disposition of the diverging twin tuyeres, which direct the blast uniformly over the whole sectional area of the furnace, while restricting the height of the zone of fusion. The tuyeres are directed downward at an angle of 5 deg., an arrangement which gives rise to a higher temperature, and therefore increases the rapidity of fusion with a minimum of oxidation. This arrangement, combined with the divergence of the tuyeres, reduces the corrosion of the lining, and thus reduces the number of stoppages for repairs.

Internally, the furnace is not cylindrical all the way up, being divided into three definite zones; the crucible, the fusion zone and the shaft. The crucible may be wider than the other zones, though this increases the quantity of coke required at starting. The shaft is slightly truncated, to prevent scaffolding, and tapers very gradually where it joins the fusion zone. At A, the sectional area is 0.14 sq. in. per lb. of pig-iron produced per hour; and this area is reduced by 35 per cent. at the fusion zone, in order to concentrate the charge and give a layer of coke of sufficient depth.

The automatic discharge enables the furnace to be emptied quickly, thus saving labour and making the work of the founders less onerous; at the same time a large proportion of the coke can be recovered, and the slag is prevented from scaffolding against the sides of the furnace.

In order to prevent loss of heat by radiation from the crucible and shaft, a space is left between the lining and casing, which space is filled up with granulated slag or broken clinker, and allows for the expansion of the lining. The throat of the furnace is provided with an annular cast-iron plate, in two pieces, to support the protective lining of cast-iron blocks. The diameter at B (Fig. 1) is equal to nine-tenths that at A, whilst the diameter at C (crucible and tuyere zone) is four-fifths that at A. The chimney is lined with about 2 in. of firebrick.

The main features of the furnace may be summarised as follows:—The distribution of the blast by means of diverging twin tuyeres, sloping downward; the arrangement for automatic discharge of the furnace contents through the bottom; the method of securing the blast-distributing main; the rotary motion imparted to the blast in the main; and the use of granulated slag or clinker for preventing loss of heat by radiation.

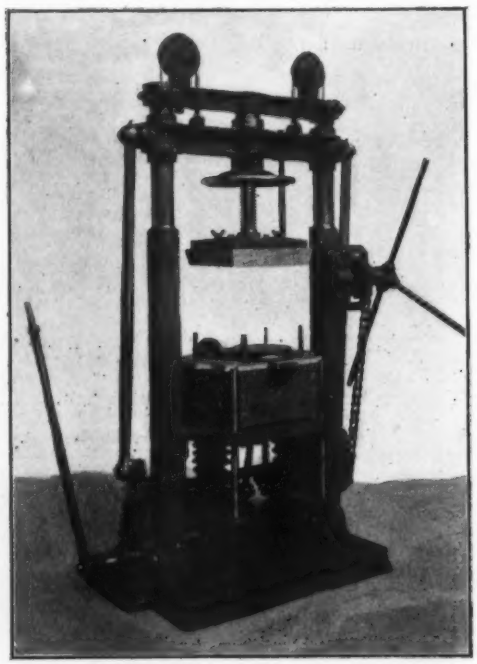


Fig. 1.—Machine with Plate in Position.

Fig. 2.—Ramming Head Swung Back after Completion of Mould.

The Taunton Mechanical-Ram Moulding Machine.

The Taunton Mechanical-Ram Moulding Machine.

The machine shown in the accompanying illustration has been specially designed for producing moulds from patterns by hand power with a small initial outlay, and yet to compete with machines using hydraulic and pneumatic power. In this machine, it is claimed, there is nothing which can possibly get out of order, and great care has been taken to make every part strong enough to withstand the hard and rough usage which is always met with in a foundry. All oil holes are fitted with spring-cap dust-proof lubricators; the main table slides are fitted with Stauffer lubricators, in addition to which they are entirely encased in collapsible leather jackets which effectually prevent the smallest amount of sand getting on to the sliding surfaces. For easy working the moving parts are balanced in every direction so that the operator has to exert the minimum of power.

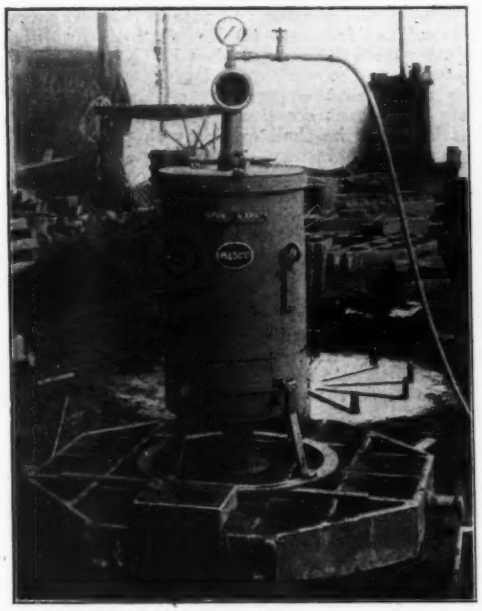


FIG. 1.—THE "MURPHY" MOULD DRIVE.

The general construction and working will be readily seen from the illustrations. The ramming head is pivoted at the base of the columns, so that it may be pushed back out of the way after the mould has been rammed. Each column is provided with a projection which, when the ram is brought forward ready for use, slides under the table at each side, thereby taking the pressure applied to the mould and making the table rigid. The ram is easily adjustable by handwheel and screw for use with patterns and boxes of various depths, and is equally efficient with either shallow or deep draws.

Each machine is fitted with a distance piece held in position on the table by the box-pins at either side; this enables pattern plates to be used having half the pattern mounted on either side. After the mould has been rammed the head is pushed back, which leaves the table free to be lowered by the hand lever on the left-hand side of the machine. This draws the pattern, leaving the mould standing on the stripping pins. The principle dimensions are:—Height, 7 ft.; width, 4 ft. 6 in.; depth, 3 ft.; standard size of moulding box, 16 in. by 14 in.; maximum size of moulding box, 16 in. by 24 in.; depth of draw, 8 in.; approximate net weight, 16 cwts. The makers are Messrs. Rudman, Lancey & Craven, Limited, St. James' Works, Taunton.

Portable Mould-Drying Set.

The accompanying illustrations show a somewhat new development in foundry mould-drying practice. The complete plant consists of a mould drier (Fig. 1) which is operated in conjunction with an engine set (Fig. 2). The mould drier consists of an outer casing containing an inner cylindrical fireplace lined with gannister, and a flat hearth arranged a short distance from the bottom, to support the gas coke used. When the air is turned on it flows into the casing, part of it going through the top of the inner fire-place, and the other part passing through a perforated adjustable ring and down the annular space between the fireplace and the outer casing. The hot and cold gases

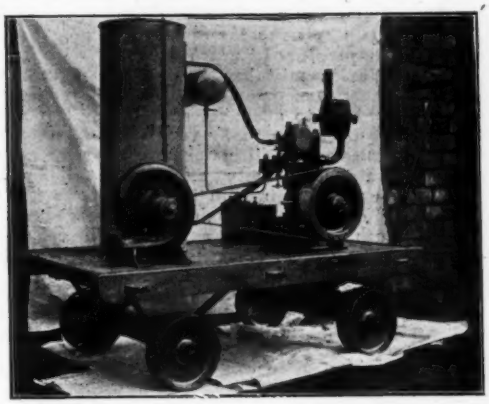


FIG. 2.—DRIER AND ENGINE ON TROLLEY.

are mixed in the chamber below. The drier can be kept always ready for use, and a great improvement is effected by causing the air to pass downwards through the fire, the carbon and smoke being consumed, instead of being deposited in the mould, which, when the air is blown up through the fire, is more or less likely to happen. The apparatus can easily be moved by two men. The height of the oven part is 3 ft. 1 in., and the total height to pressure gauge, 5 ft. 4 in., the diameter of casing being 21 in.

The engine set comprises a ¾-h.p. vertical valveless petrol engine, fixed on a trolley, and coupled by a belt to a No. 0 blower supplying 240 cub. ft. of air per minute max. The makers and patentees of the apparatus are Murphy, Stedman & Company, Limited, 180, Gray's Inn Road, London, W.C.

Correspondence.

Blast Quantity and Pressure in Cupola Working.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I am pleased to note by Mr. Liardet's letter in your last issue, that the problem of blast quantity and pressure in cupola working is receiving attention elsewhere, and that experiments on very similar lines to those I gave before the British Foundrymen's Association have been carried out by his firm.

It is rather disappointing, however, to hear that the results obtained were different to mine. As Mr. Liardet has not given any figures, it is impossible for me to account for the difference; but in reply to his suggestion that the error lies in the method adopted by me, I would point out that, as mentioned in the Paper, the Venturi-tube method of air measurement was adopted only after careful experiment and consideration of other methods. The method described by Mr. Liardet, as used by his firm, was amongst those considered and discarded as being less accurate than the Venturi tube. In addition to the disadvantages, mentioned by Mr. Liardet himself, of the bad effect on the blower efficiency and the overloading of the motor by his method, it is obvious that the quantity of air entering the blower is not necessarily the same as that delivered to the cupola; leakages in the blower, etc., may be the source of considerable error. Further, the temperature and pressure of the air entering the blower is very different from that delivered to the cupola, and corrections have to be made for this. On the other hand, as described in the Paper, the Venturi tube measured the *quantity of air actually entering the cupola, and at the pressure and temperature at which it was delivered.*

Mr. Liardet is mistaken in suggesting that the amount of change of pressure in the Venturi tube was large, and likely to affect its accurracy. The variation of pressure was actually very small as compared with the range over which the instrument remained quite accurate. The alternative suggested by Mr. Liardet has no advantage in this respect, as the coefficient of discharge through a sharp-edged orifice changes much more rapidly, and cannot be calculated with the same degree of accuracy as in the Venturi tube.

The absence of figures and full particulars of Mr. Liardet's tests prevents further discussion for the present, and I await these particulars with interest.

Yours, etc.,

F. J. COOK.

Birmingham,
August 21, 1913.

Steel in Cupola Mixtures.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—In the letter on Steel in Cupola Mixtures, which you publish in the August number, there is an error which I shall be glad if you will correct. Quoting Mr. Coe's Paper in the June "F. T. J.," the letter states "bar 40 was made up to contain 1.2 manganese and 0.2 sulphur, yet bar 40 was grey, stood 14.8 tons tensile, and actually contained 0.85 manganese and 0.27 sulphur," etc. The latter figure should have been 0.027 sulphur.

Yours, etc.,

H. SAYERS.

Hunslet,
August 16, 1913.

Piece-work in Foundries.

Following a report by Sir Ernest F. G. Hatch, Bart., on his investigation as to the application of the "Particulars" section of the Factory and Workshops Act, 1901, to foundries, a draft Order has been issued by the Secretary of State, applying the provisions of Section 116 of the Factory and Workshop Act, 1901, with modifications, to works in which iron or steel founding is carried on, so far as concerns the work of moulders. The draft is as follows:—

In pursuance of Section 116 of the Foundry and Workshop Act, 1901, I hereby make the following Order:—The provisions of the said section shall apply, subject to the modifications hereinafter contained, to non-textile factories and workshops in which iron or steel founding is carried on, so far as concerns the work of all persons employed as moulders.

The said section shall be modified so as to read as follows:—

(1) The occupier or contractor shall, for the purpose of enabling each worker who is paid by the piece to compute the total amount of wages payable to him in respect of his work, cause to be published particulars of the work and rate of wages applicable thereto, as follows:—(*a*) He shall furnish every worker with written particulars of the rate of wages applicable to the work done by him at or before the time of his first employment on the work and on every subsequent occasion when the rates are fixed or altered; or he shall exhibit such particulars on a placard in the factory or workshop. Provided that if the rates are not ascertainable before the work is given out, the particulars shall be furnished to the worker in writing when the work is completed. (*b*) Such particulars of the work done as affect the amount of wages payable to each worker shall be furnished to him in writing when the work is completed.

(2) Where the work is done in common by a gang of workers it shall be sufficient if the particulars of the work done by the gang and of the rate of wages applicable thereto are furnished to the member of the gang to whom the wages of the gang are paid by the employer.

(3) The particulars, either as to rate of wages or as to work, shall not be expressed by means of symbols; but this shall not prevent the occupier or contractor from describing any work which is of a standard kind known to the persons employed by a particular number, letter or name, by means of such number, letter or name

(4) Any placard exhibited in pursuance of the foregoing provisions shall contain no other matter than particulars of rates of wages and shall be affixed in such a position as to be easily read by all persons to whose work the particulars relate.

(5) If the occupier or contractor fails to comply with the requirements of this section, he shall be liable for each offence to a fine of not more than ten pounds, and, in the case of a second or subsequent conviction within two years from the last conviction for that offience, not less than one pound.

(6) If anyone engaged as a worker in the aforesaid class of work, having received such particulars, whether they are furnished directly to him or to a fellow workman, discloses the particulars for the purpose of divulging a trade secret, he shall be liable to a fine not exceeding ten pounds.

(7) If anyone for the purpose of obtaining knowledge of or divulging a trade secret, solicits or procures a person so engaged to disclose such particulars, or with that object pays or rewards any such person, or causes any person to be paid or rewarded for so disclosing such particulars, he shall be liable to a fine not exceeding ten pounds.

Inventions.

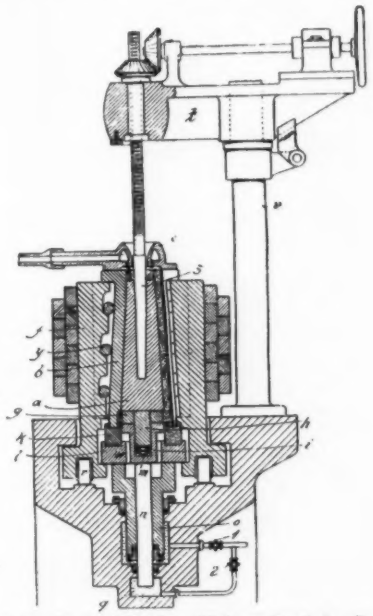
Applications for Patents.

An Asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

16,565.*Manufacture of electrolytic iron. Société "Le Fer."
16,653. Steel making. R. Hyde and J. R. Hyde.
16,703.*Motive power-driven jarring moulding-machines. H. Rudman, H. T. Lancey and J. E. H. Craven.
16,711.*Optical pyrometers. F. Lagoutte.
16,769. Machinery for preparing sand and coal for foundry purposes. G. E. Sherwin.
16,821. Manufacture of steel. G. J. Boyle, Viscount Chetwynd.
17,116.*Moulding machines. C. Bouillon.
17,555. Foundry moulding boxes. Thompson Bros. (Bilston), Limited, W. B. Thompson and H. K. Bather.
17,590. Metallurgical furnaces. L. F. Tooth.
17,724. Casting-machines. W. Mann.
17,813. Production of boron alloys. A. Rollason.
17,869.*Method of treating steel and iron in the manufacture thereof. C. R. Gostling.
17,927.*Optical pyrometers. (Siemens & Halske Akt.-Ges., Germany).
17,955.*Continuous ingot-heating furnaces. F. E. Siemens.
17,956.*Regenerative gas furnaces. F. K. Siemens.
18,014. Construction of furnaces and cupolas. J. Moeller.
18,116.*Making or refining steel. E. Humbert.
18,161.*Non-corrosive metallic alloy. J. Coup and E. Allbaugh.
18,167. Casting-moulds. E. Hock and Patent Anstellungs-und Verwertungs G.m.b.H.
18,212.*Process of producing alloys stable against strong acids. W. Borchers and R. Borchers.

Abstracts of British Patent Specifications recently accepted.

21,738 (1912). *Method of and Apparatus for Solidifying Molten Steel in Casting into Ingots.*—B. Gerdau, 13, Neanderstrasse, Düsseldorf, Germany.—The steel ingot *a* is cast in the usual manner in the mould *b* from above. This mould is composed of a number of parts, which can be moved on the base-ring *k* and are surrounded by a circular body *f*. In the ring *i* the bearing-ring *l* is supported underneath and can be moved therewith over the bars on the rollers *r* arranged on the ring *f* for the purpose of enabling the pouring of the molten metal into the mould to be effected and then carrying the mould into the press again. The different parts of the mould *b* may be connected with one another by damming plates placed in grooves, and in order to prevent the flowing of the molten steel through the joints and its contacts with the damming plates, the joints are filled up with refractory material. The molten ingot is compressed in the transverse direction and made compact. At the same time, however, the ingot can also be pressed into the upwardly-narrowing mould by pressure on the bottom of the ingot by means of the bottom pieces *g h i* of the mould, thereby the molten ingot is pressed and concentrated in the longitudinal direction also. The effect of the pressing in the transverse direction is produced by the whole mould that narrows outwardly upwards being forced by a hydraulic ram *o*, for example, by screw-gear, etc., into the ring *f* that is similarly narrowed. Thereby the different parts of the mould are moved in the transverse direction of the ingot, which is subjected to lateral pressure and is concentrated. In order to reduce the friction, rollers or balls *y* are arranged which support the parts of the mould in relation to the ring *f* and rotate when the mould is moved. The effect of the pressure in the longitudinal direction of the ingot is obtained directly by a special hydraulic ram *n*, which moves in a special cylinder *q*. Thereby the tapered ingot is forced into the mould, which is narrowed inside. The rapidity of the pressing in the transverse or in the longitudinal directions or the rapidity of the movements by means of which this is carried on is regulated by a main piston, to which any desired slower or quicker movement can be imparted by a motor by means of screw gear of any preferred ratio. By means of the regulating valves 1 and 2 introduced into the supply pipe the velocities of the pistons *o* and *n* can be varied in relation to each other. In order to increase the effect for the purpose of preventing honeycombing or the formation of shrinkage cavities, a gas-burner is employed that is movably arranged in relation to the gas-supply pipe, so that it can be put over the mould and be subsequently moved to the side. When the ingot has been cast, heat is conveyed through the burner *c* to the top of the mould and ingot, and a subsidiary heating of the top effected for facilitating the ascent of the light slag parts, etc., of the ingot. The pressing of the ingot in the transverse and longitudinal directions can be effected at the same time. The production of hollow ingots may be effected by forcing a tapering mandrel 5 into the molten ingot by means of a screw-gear *n;*

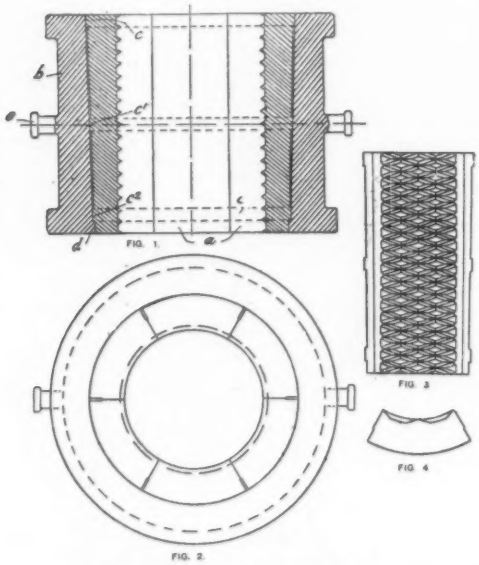


Apparatus for Solidifying Molten Steel in Casting the Same into Ingots.

the bottom-piece *h* supported by a spring *m* being pushed back if necessary, the spring being compressed. The screw-gear, and if necessary the motor, is suitably mounted on a support *t* that pivots on the column *v*, so that, like the burner *c*, the mandrel can be removed above the mould, so that the mould may be free for the pouring in of the molten steel for the ingot out of a ladle movable above the same. As the cooling of the ingot proceeds the mandrel can be gradually withdrawn from the ingot.

423 (1913). *Manufacture of Chilled Metal Rolls and of the Chills and Appliances by which they are Produced.* The Brightside Foundry and Engineering Company, Limited, and F. W. Firth, Sheffield.—Fig. 1 is a vertical section of one of the improved segmental roll chills and outer casing; Fig. 2 is a plan; Fig. 3 is an elevation of one segment; Fig. 4 is a plan of the same. A circular chill is employed formed of a number of longitudinal segments *a*, carefully machined and fitted at their radial joints, and secured together with an outer casing *b*, formed with trunnions after the fashion

of an ordinary chill. The casing is bored of uniform taper to within a short distance of its bottom end, which is left slightly smaller in diameter at *d* to prevent the segments passing too far through the case. The segments themselves being turned on the outside with three or more circumferential bands *c*, c^1, and c^2, which form reduced bearing surfaces within the chilled case, to reduce friction and to facilitate the segments being dropped or knocked out when the roll casting has been made

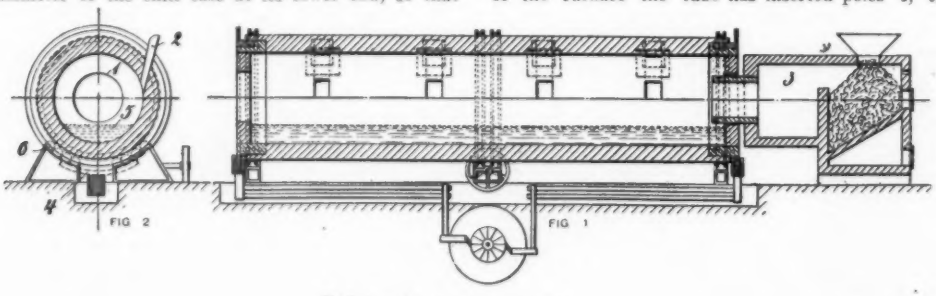


Improved Chilled Metal Rolls.

and the casing *b* reversed on the trunnion *e*. The lower band c^2, on the outside of the segments, forms an abutment with the projection *d*, made by the reduction of the diameter of the chill case at its lower end, so that all the chills are true longitudinally, and as they are carefully turned outside and machined on their radial joints, when they are driven home, the grooves or pro jections which are formed on their inner circumference register much more correctly than by any other method. In order that the conngurations on the matrix formed by these segmental chills may be accurately delineated, A carefully built-up pattern is made from which all the segments in a set are cast. This pattern is so made as to divide the configurations equally and uniformly between all the companion segments, so that when a set of chills cast from this pattern are assembled and closed right in their outer casing a casting can be made which after it has set, can be removed with its chills from the outer casing, the segments which form the chills can then be detached, leaving a roll with symmetrical impressions of the pattern or configuration on its chilled surface.

12,542 (1912). *Composition of Matter for Treating Cast Iron and Steel.* J. R. C. Marsh, 2,111, Auburn Avenue, Cincinnati, Ohio, U.S.A.—A mixture of materials is used with which the metal is treated while in a molten state, and which acts on the metal. As an example of the mixture of materials which gives good results, the patentee cites the following :—Ferro titanium, 2 per cent.; metallic copper, 1.50 per cent.; ferro chromium, 0.50 per cent.; boric acid, 0.20 per cent.; arsenic, 0.20 per cent. These figures give the per cent. of the weight of each ingredient as compared with the total weight of the metal to be treated. In the case of cast iron the definite portion of the mixture is placed in the ladle, and the molten metal is poured on it. The ladle is held for three or four minutes to give the mixture a chance to act. In the case of cast steel the molten steel is held from five to ten minutes before pouring. The action of the mixture tends to raise the heat slightly so that the metals will pour easily. During the treatment certain objectionable substances such as sulphur, phosphorus, etc., are removed. The patentee claims that cast iron produced by this process is harder and the grain finer. The metal has a greater elastic limit, and a greater tensile strength. Both the iron and steel are "hot hard," i.e., they retain their rigid form at high temperatures, and in this respect resemble high speed steel. They take a high polish. The temperature at which the iron or steel is cast is that for the ordinary casting purposes, but if the metals are to be quenched after casting, care should be taken in regulating the temperature of the metal. Thus the quenching temperature should not be carried much beyond 1,325 deg. Fahr. Steel casting will always be found to be better when heated after casting and then quenched, especially so when high elastic limit and tensile strength are required.

13,577 (1912). *Process and Apparatus for Refining Metals by Heating.* Dr. Alois Helfenstein, Pakoringasse, 4, Vienna, Austria.—Figs. 1 and 2 are respectively a vertical longitudinal section and a transverse section of a furnace for carrying out the process. The tubular-formed Martin furnace 1 is charged through the openings 2 with fluid or cold charge and additional substances, and receives the heating gas for carrying out the normal Martin process through the generator 3. In the bottom of the furnace the tube has inserted poles 4, through



Refining Metals by Heating.

which the short circuit current from the dynamo engine or from a division of a transformer secondary current circuit can be transmitted at any time to the bath 5. The poles consist of first-class conductors, are water-cooled and inserted so that they come into direct contact with the metal bath, and are connected outside the furnace with the source of current, but, notwithstanding their arrangement inside the tube, are situated outside the fuel heating zone, and are thus not exposed to the high temperature. The tubular furnace is suitably seated on rollers 6 and can be swung and rotated around its axis by a suitable driving mechanism. The movement can be effected intermittently, that is, with interruptions always, however, during the carrying out of the process.

19,657 (1912). *Casting of Steel Ingots.* F. Kohlhaas, 38, Cranachstrasse, Düsseldorf, Germany. Experiments made by the inventor have shown that the

formation of cavities may almost entirely be avoided by the employment of a funnel having an elongated or slit-like discharge opening, as the metal is thereby caused to issue in the form of a jet or stream of small width. This broad and thin stream passing out of the funnel divides into a number of thin streams and drops upon the surface of the molten metal contained in the mould without penetrating into the mass. The molten metal in the mould therefore quickly comes to rest and solidifies uniformly the formation of the "funnel" being thereby practically limited to the "lost head." The division of the inflowing stream into a number of thin streams accelerates the escape of gases out of the steel and thus reduces the formation of blisters. The improved casting funnel should preferably have a discharge opening the ratio of the width to the length of which should be about 1 : 6—8. For example, instead of using a circular opening having a diameter of 25 mm., an elongated slit-shaped opening 9 mm. x 55 mm. should be used, compare Figs. 1, 2 and 3. In order to avoid a disproportion between the length of the opening and the diameter of the funnel, the opening may be made of a curved or irregular shape, such as, for example, an S - or an N-shape, or if desired the opening may comprise two slots arranged side by side or in the form of a cross. The opening should extend in the vertical direction to avoid any liability to obstruction. The dividing action of the improved discharge opening upon the issuing stream may be enhanced by enlarging the discharge passage conically in the downward direction;

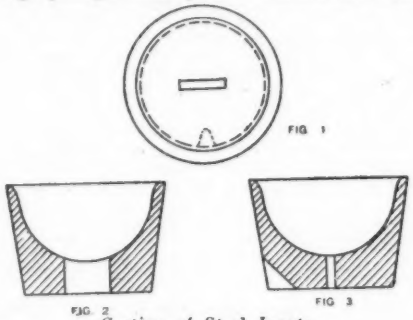


FIG. 1

FIG. 2

FIG. 3

Casting of Steel Ingots.

the increase, in this instance in the width and the length being about 25 to 30 per cent. This conical enlargement is principally intended for use in connection with moulds of moderate height, and has the additional advantage of reducing liability of obstruction.

24,440 (1912). *Production of Tool Steel and other High Grade Steels.* The Firm Dellwik-Fleischer Wassergas Gesellschaft mit beschränkter Haftung, 5, Marienstrasse, Frankfurt a.M., Germany.—The invention relates to a new process for the production of steel of high quality by clearing *in vacuo*. The fluid steel is placed in one or more suitable casting pots. The steel must now be allowed to rest quietly in these clearing vessels for a long time, so that it may clear before it is poured out. For this purpose, iron containers are employed lined with refractory material, and of such dimensions that there is sufficient space in them for the clearing vessels. These containers (which are suitably sunk in pits) have a turned flange upon their upper edge upon which a similarly flanged cover may be fastened in air-tight fashion by the aid of packing material. If now the clearing vessel, after having its surfaces highly heated, preferably to the temperature of fusion of the steel, filled with fluid steel, and loosely covered with a cover of chamotte, is put into such a pit container, the interior surfaces of which are similarly highly heated, and the cover of this latter then fastened on air-tight, and the pit exhausted, some very important advantages are simultaneously obtained. In the first place the vacuum powerfully assists the separation of gas, so that the clearing process is not only improved in quality, but the time taken by it is diminished. But besides this the large interior surface of the vacuum chamber, together with the surfaces of the clearing container, constitute a heat storer of very great capacity, and also the vacuum around the clearing vessel diminishes the loss of heat by conduction so considerably that there is no fear of the steel becoming viscous, even if the clearing vessel is in the exhausted pit for hours.

1,326 (1913). *Process of and Apparatus for Delivering Molten Metal.* G. Mellen, East Orange, New Jersey, U.S.A.—Fig. 1 is a transverse vertical section of the melting pot and appurtenances; Fig. 2 is a horizontal section of the pot on the line II—II of Fig. 1, looking upward; and Fig. 3 is a perspective view of a water-evaporating trough. The apparatus illustrated comprises a hemispherical cast-iron melting pot 1, set in a furnace 2. A flat cover 3 rests on and makes a steam-tight joint with the upper edge of the pot, being removably secured thereto by clamps 4 or otherwise. A water-supply pipe 5, containing a shut-off cock 6, is connected by a union 7 to a nipple 8 extending through the cover. This nipple

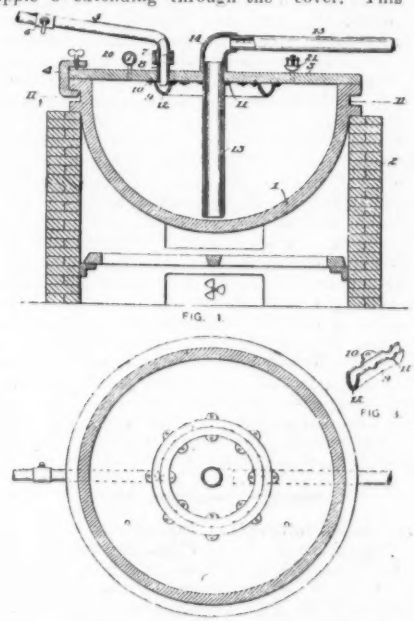


FIG. 1.

FIG. 3.

FIG. 2.

Apparatus for Delivering Molten Metal.

opens into an annular vapourising trough 9, having marginal lugs 10, by which it is secured to the underside of the cover. The upper edge of the trough has notches 11 at various points, to permit the escape of steam. Openings 12 may also be provided through which some of the water runs in fine streams on to the surface of the metal, where the water vaporises. A metal delivery pipe 13 extends centrally upward through the cover, making a tight joint therewith, and is connected by an elbow 14 to a horizontal pipe 15. In use, the metal, for example a soft metal or alloy, is charged into and melted in the pot 1. The cover 3 is then clamped on the pot and water is supplied through the pipe 5, the cock 6 being then turned to the closed position. The water vapourises in the trough and on the surface of the molten metal and the pressure in the enclosed space above the metal soon rises to a point sufficient to force the metal upward through the pipe 13 and deliver it through the pipe 15 to the ingot mould or other desired point. The valve 6, instead of being a stop-cock of the ordinary kind, may be a regulating valve so arranged as to admit only sufficient water to produce, when changed into steam, the required pressure within the melting chamber. A pressure gauge 20 may be provided on the lid, if desired and a safety valve 21 may also be used to relieve any excessive pressure.

Foundry Trade Class in Glasgow.

The foundry trade class at Napiershell School, Glasgow, will resume on Tuesday, September 16. The class is designed for pattern-makers and moulders, and covers woodwork, lead, stucco, iron, brass and steel. A summary of the work is as follows:—

Moulding.—Instruction on how to make and read drawings and estimate the cost of work; determining the weight of castings and other workshop calculations; moulding sands; hydrostatic and gas pressures in moulds; liquid shrinkage; weighting of moulds; venting and ramming; warping and fracture of castings; green sand, dry sand, and loam moulding; open sand; single and double turn-over; two part, three part, cheek box, and snap flasks; plate moulding; embossing, by claying out and reverse moulding; moulding from guides; machine moulding; false cores and drawbacks; mixture of metals for different types of castings in iron and brass; brass alloys; cupola practice; brass foundry practice; etc. Students will mould and cast in metal examples selected.

Pattern-making.—Workshop drawing; workshop calculations; patterns in wood, lead, and stucco; shell, solid, and skeleton patterns; propeller work; loam boards and strickles; guides and apparatus for non-pattern moulds; construction of core boxes; tooth gearing, involute and cycloidal; laying off large curves. Stucco patterns will be made illustrating track, centre, elliptical, guard, and spindle work.

The coming session will be the sixth since the inauguration of the class, and the average enrolment for the last three years has been over 50 each year. The Glasgow School Board, under whose auspices the class is conducted, have been greatly pleased by the manner in which this class has been taken advantage of, and have under consideration the erection of a special building for the class so that its usefulness may be further extended.

A Canadian Metallurgical Labortory.

The Mines branch of the Canadian Department of Mines has installed at Ottawa a modern laboratory for the purpose of experimental concentration and metallurgical tests with Canadian ores and minerals. The laboratory appears to be already well-equipped with both standard-size machinery and small-scale apparatus, and an experimental roasting and sintering plant is to be added shortly. The plant will be operated free of all charges, including assays necessary for test purposes, on Canadian ores, and reports of tests will be incorporated in the publications of the Mines Branch. Under ordinary conditions tests will be made by the Mines Branch officials, but arrangements may be made whereby engineers or other competent persons may supervise their own experiments. Arrangements regarding tests will be in the hands of Dr. Eugene Haanel, Mines Branch, Department of Mines, Ottawa.

THE late Lord Rendel, a vice-chairman of Sir W. G. Armstrong, Whitworth & Company, Limited, left estate of the gross value of £652,328, of which £480,169 is net personalty.

MR. N. W. MCLACHLAN has been appointed superintendent of the Walton and Kirkdale Technical Institute and Special Superior of Engineering in the several institutes in Liverpool.

MR. B. FREEBOROUGH, who has been associated with the Brightside Foundry and Engineering Company, Limited, since its inception some twenty years ago, has now retired, owing to indifferent health. Mr. P. J. Benson has been elected to fill the vacancy on the directorate.

Trade Talk.

THE STANDARD METAL COMPANY, of Birmingham, are retiring from business.

A RECEIVING order has been made against Mr. W. Sutcliffe, engineer, Hollins Mill, Sowerby Bridge, Yorks.

MESSRS. J. GILLOTT & SON, colliery engineers, of Barnsley, are about to erect a new foundry in Mona Street.

MR. G. HIBBERT, engineer, 57, Barfield Road, Pendleton, Salford, is paying a first and final dividend of 1s. 2½d.

THE CREWKERNE ENGINEERING AND FOUNDRY COMPANY, of Hermitage Street, Crewkerne, have disposed of their business to a London concern.

THE plant at the works of G. Birch & Company, Limited, Islington Grove, Salford, will be offered for sale by public auction on September 10.

THE new furnace which T. & I. Bradley, Limited, have built at their Caponfield Works for the production of best foundry iron, has been put into blast.

SUGGESTIONS for a composition scheme not having materialised, the estate of Mr. F. W. Tannett-Walker, of Leeds, has gone into bankruptcy.

THE JUDSON-JACKSON COMPANY, LIMITED, have removed from 14, Great Smith Street, Westminster, London, S.W., to 50, Marsham Street, Westminster, London, S.W.

MESSRS. H. H. L. LEWIS and W. HENDRA, Townmead Road, Fulham, London, trading under the style of Lewis, Hendra and Son, ironfounders, have dissolved partnership. Mr. W. Hendra will continue the business.

MR. J. W. SAUNDERSON, engineer and brass and ironfounder, carrying on business under the style of Saunderson and Son, New Bridge Ironworks, Eastgate, Louth, has paid a second and final dividend of 1s. 5d. in the £.

A RECEIVING order has been made in connection with the affairs of Mr. W. N. King, ironfounder, Chilvers' Coton, Nuneaton, Warwickshire, trading as the Northern Ironworks Company, and he has been adjudged bankrupt.

MESSRS. THERMIT, LIMITED, have removed their works to 675, Commercial Road, London, E., to which address all goods should in future be sent. All communications should be addressed to 27, Martin's Lane, Cannon Street, E.C., as before.

MESSRS. G. P. WINCOTT, LIMITED, of 180, Attercliffe Road, Sheffield, have recently secured the contract for the crucible melting and annealing furnaces for the new foundry Messrs. Burys & Company, Limited, of Sheffield are erecting.

GJERS, MILLS & COMPANY, LIMITED, of Middlesbrough, have appointed Mr. William McLean, Stirling Chambers, Sheffield, as their agent for the sale of "Ayresome" hematite pig-iron in Lancashire, South Yorkshire and the Midland Counties.

THE new works at Trafford Park, Manchester, of the Carborundum Company, are now completed, and the firm announce that they will shortly transfer their stock thither from their premises at 29, Clifton Street, Finsbury Square, London, E.C.

THE shareholders of the H. D. R. Welding and Engineering Company, Limited, have passed a resolution to wind up the company voluntarily, for which purpose Mr. M. B. Mahoney 584, Holloway Road, London, N., has been appointed liquidator.

An order has been placed with the Manchester Furnaces, Limited, of Ashton New Road, Manchester, by the Singer Manufacturing Company, of Kilbowie, for 10 solid fuel furnaces, each furnace having an inside working dimension of 5 ft. by 4 ft. by 2 ft.

A FIRE causing damage estimated at between £2,000 and £3,000 occurred recently at the engineering works of Mr. Robert Knox, The Quay, Douglas, Isle of Man. The fire started in an oil store, and spread with great rapidity to the other parts of the building.

MR. D. DOUGLAS, sole partner of the Glasgow Patent Moulders' Blacking Company, Fleming Street, Port-Dundas, Glasgow, has suspended payment, and has granted a trust deed in favour of Mr. Joseph Allison, jun., C.A., 133, St. Vincent Street, Glasgow. The business has been sold to Mr. John MacEwan.

MESSRS. J. S. J. REDFERN and H. W. C. ROBBINS, carrying on business as engineers at 93½, Hurst Street, Birmingham, under the title of Redfern, Robbins & Company, have dissolved partnership. The business will be continued by Mr. J. S. J. Redfern, who will trade as Redfern & Company.

BULLIVANT & COMPANY, LIMITED, wire rope manufacturers, engineers, etc., 72, Mark Lane, London, E.C.; the Derwent Foundry Company, Limited, Exeter Place, Derby; and Douglas & Grant, Limited, Dunnikier Foundry, Kirkcaldy, have become members of the British Chamber of Commerce in Paris.

MESSRS. C. RICHARDS, 78, Bull Street, Birmingham, A. E. Wilcox, Paragon Works, Henrietta Street, Birmingham, and H. E. Pitman, carrying on business as brassfounders, at Paragon Works, Henrietta Street, Birmingham, under the style of Wilcox and Pitman, have dissolved partnership, so far as regards Mr. C. Richards

MESSRS. CURRAN BROTHERS, 72, Bute Street, Cardiff, have just received a contract from the Darlington Forge Company, Limited, Darlington, for what will probably be the largest steel-casting annealing furnace in the United Kingdom. The interior dimensions are 48 ft. by 18 ft. 6 in. by 11 ft. 6 in., with a right-angle projecting chamber 13 ft. 6 in. by 11 ft. by 9 ft. This furnace will accommodate the largest stern or rudder frame yet designed, and will anneal single castings weighing 75 tons. The following are analyses of samples of gas (made by Prof C. K. Tinkler, of Birmingham) taken from one of the company's patent furnaces with an open chamber of a reverberatory type, and the results indicate that the company's claims for their furnaces for the combustion and heat treatment of metal are not exaggerated. The samples were taken from a furnace at Messrs. D. F. Tayler & Company's works, George Street Parade, Birmingham :—First sample (taken in course of ordinary working, after stoking with breezes, etc.): Carbon dioxide, 9.5 per cent.; oxygen, 9.9 per cent.; carbon monoxide, nil; sulphur dioxide, trace; nitrogen (by difference), 80.6 per cent. Second sample (taken five minutes after stoking with ¼ cwt. of coal): Carbon dioxide, 10.2 per cent.; oxygen, 9.8 per cent.; carbon monoxide, nil; sulphur dioxide, trace; nitrogen (by difference), 80 per cent.

A COMPULSORY ORDER was made last May against Brown & May, Limited, of the North Wilts Foundry, Devizes, and the report of Mr. W. J. Warley, Official Receiver, has now been issued to the creditors and shareholders. Accounts have been lodged showing liabilities £41,828 and assets valued at sufficient to yield a surplus of £15,449 after payment of all debts, but a deficiency of £15,050 with regard to contributories. The Official Receiver reports that the company was formed in November, 1895, with a nominal capital of £35,000 divided into 20,000 6½ per cent. cumulative preference and 15,000 ordinary shares of £1 each, to acquire and carry on the engineering business of Brown & May, established in 1854 at Devizes by Messrs. W. Brown & C. N. May. The purchase price of £45,000 was satisfied by the payment of £20,000 in cash and the allotment of 12,106 preference and 12,894 ordinary fully-paid shares. A prospectus was published which resulted in 15,000 5 per cent. debentures and the whole of the remaining share capital being allotted for cash. After paying the cash purchase consideration £5,000 remained for working capital. A second prospectus was issued in August, 1912, offering £10,000 5 per cent. second debentures for subscription, and in response bonds for £6,305 were applied for and allotted. By the end of October, 1912, the cash provided by the second debenture issue had been expended, and the company was again short of working capital. The Court on March 18 last appointed Mr. W. F. Marreco, C.A., as receiver and manager on behalf of the debenture holders, who is in possession of all the assets and at present is carrying on the business.

THE MIDLAND EMPLOYERS' FEDERATION, which was formed temporarily during the recent labour troubles in the Midlands, has now been constituted upon a permanent basis, with the support of the majority of the largest industrial concerns in the district. Ten trade sections or committees have been formed as follows in connection with the Federation :—Engineering trades (representing engineering firms which employ workmen other than those strictly regarded as engineers), wagon builders, bridge builders, boiler makers, tube manufacturers, general ironfounders, metal rollers and brass workers, hollow-ware manufacturers, bolt and nut manufacturers, and electrical trades. The new federation has been established upon quite distinctive lines; for instance, unlike the majority of employers' associations, it places no restrictions as to membership upon manufacturers, however diversified their interests may be, provided they subscribe to the conditions, which, among other demands, call for the strict observance of agreements made by the federation with trade union leaders duly authorised to act on behalf of bodies of workpeople. In fact, the basis of the federation agreements is the understanding that was arrived at in July last as the result of the conference at which Sir George Askwith presided, between the federation and the Workers' Union and other labour organisations. "The movement," said Mr. A. Warne Browne, the secretary of the federation, "will go a long way in the direction of preventing industrial warfare, because there will be established by mutual consent, as between the employers and the representatives of the workmen, working agreements. Hitherto there has been no proper understanding in many industries between organised capital and organised labour. Manufacturers have dealt with their disputes in their own way according to their individual conception of what was right and just. In this new movement broad principles will have to be recognised by all who are members of the Employers' Federation, and then—presuming always that the agreements will be regarded by employers and workmen alike as sacred and binding—negotiation and collective bargaining can proceed apace."

AT the Stockton-on-Tees Bankruptcy Court, recently, Messrs. J. L. Riley and C. A. Riley, trading as the Richmond Iron and Steel Company, at Stockton, came up for their public examination. The statement of affairs showed gross liabilities £45,134, expected to rank £34,224 and a deficiency of £29,006, and the causes of the failure were set out as "shortage of capital, general strikes and foreign competition." In reply to the Official Receiver (Mr. H. Meredith Hardy), Charles Archibald Riley, who had controlled the financial side of the business, said he and his brother took over the works from his late father's trustees in 1910. According to a statement then prepared, the business was solvent. The Official Receiver said that, taking into consideration the liabilities the estate, as far as he could ascertain, was insolvent at the time the debtors took it over. Debtor: Well, the estate was insolvent if we had been called upon to pay up annuities and legacies at their capital value; but the estate, as far as my father was concerned, was not insolvent. Their balance-sheets showed that in 1909 a profit of £197 was made, in 1910 a profit of £2,005, in 1911 a loss of £738, and in 1912 a loss of £4,749, but he admitted balance-sheets submitted to the North-Eastern Bank, who were creditors for an overdraft of £8,715, showed a profit of £883 in 1910, £1,261 in 1911, and £2,123 in 1912. The Official Receiver: As a matter of fact, the balance-sheets were incorrect, and you gave them to the bank for the purpose of bolstering up your credit? Debtor: No; we did not discover our real position till we had an investigation in June this year. It was admitted by debtor that under contract they had been supplying four-fifths of their material to Messrs. Hall and Pickle, Manchester, and for the last eight months the selling price had been £6 12s. 9d., whereas the average selling price in the trade had been £7 7s. 7d. At the end of 1911 they realised they were selling under the market price to Messrs. Hall & Pickle, but owing to lack of capital and the fact that the firm named paid them weekly, they continued to have them as their sole selling agents. They did not realise that they were insolvent until July. The examination was adjourned to October 15.

Personal.

THE late Mr. J. R. Ross, manager of the Parkhead Steel Works, Glasgow, left estate valued at £7,730.

THE late Mr. Joseph Carr, a director of Gelling's Iron Foundry Company, Limited, left estate valued at £918.

THE late Mr. A. J. Henderson, a director of D. & W. Henderson & Company, Limited, Glasgow, left personal estate valued at £7,738.

MR. C. M. SCHWAB, the President of the Bethlehem Steel Company, has been elected a director of the American Locomotive Company.

THE late Mr. William Jarvis, of Messrs. William Jarvis & Sons, ironfounders, of Middlestown, Wakefield, left estate valued at £7,215.

MR. H. RIPLEY, who was a director of the North-Eastern Steel Company, Limited, left estate valued at £112,362 gross, with net personalty £104,567.

DR. SWINDEN, of S. Fox & Company, Limited, Stocksbridge, Sheffield, has been the recipient of a presentation from the officials and men on the occasion of his marriage.

MR. F. BACON, of the Royal Naval College, Greenwich, has been appointed Drapers' Professor of Engineering at the University College of South Wales and Monmouthshire.

MR. T. F. JONES has resigned his position with Guest, Keen & Nettlefolds, Limited, to take up the position of manager of the Wishaw Iron & Steel Works of the Glasgow Iron & Steel Company, Limited.

THE late Mr. G. H. Baines, managing director of Messrs. William Gray & Company, Limited, Central Marine Engine Works, West Hartlepool, has left £112,770, with net personalty £97,356.

PROFESSOR S. M. DIXON has been appointed to the new chair in civil engineering in the City and Guilds (Engineering) College, which was recently created by the Imperial College of Science and Technology.

THE gross value of the estate of the late Mr. Allen Ransome, the founder and for many years chairman of A. Ransome and Company, Limited, of Newark-upon-Trent, is £20,698 gross with net personalty nil.

MR. GEORGE RALPH has resigned his position as general manager of the Electric and Ordnance Accessories Company, Limited, Birmingham, to join the staff of the British Thomson-Houston Company, Limited, Rugby.

THE late Mr. W. H. Walker, formerly a partner of Walker, Eaton & Company, steel manufacturers, Wicker, Sheffield, left estate of the gross value of £61,030 13s. 3d., with net personalty £60,277 14s. 8d.

MR. WALTER GIBB GRAY, commercial manager; Mr. Andrew Simpson MacHarg, C.A., of Messrs. M'Clelland, Ker & Company; and Mr. Thomas Bond Rogerson, have been elected directors of James Dunlop & Company, Limited.

THE late Admiral Sir Archibald Lucius Douglas, G.C.B., G.C.V.O., a director of Hadfields, Limited, and of Palmers Shipbuilding and Iron Company, Limited, left estate of the gross value of £4,543, of which £3,440 is net personalty.

PROFESSOR ARCHIBALD BARR, D.Sc., the occupant of the Regius Chair of Civil Engineering and Mechanics in the University of Glasgow, having completed 24 years of tenure of that office, has intimated his intention to retire as from October 1.

MR. RONALD RITCHIE, eldest son of Mr. James Ritchie, the founder of the firm of J. & R. Ritchie, Limited, Acklam Foundry, Middlesbrough, has been the recipient of a presentation from the officials and men on the occasion of his coming of age.

MR. W. G. HASLAM, of the Haslam Foundry and Engineering Company, Limited, has been elected on an Advisory Committee by the authorities of the Derby Technical College in connection with the equipment for the engineering classes at the College.

MR. W. J. BROOKE, who has been for some years departmental manager of steelworks to the Frodingham Iron and Steel Company, Limited, has been appointed works manager to the Shelton Iron, Steel and Coal Company, Limited, of Stoke-on-Trent, in succession to Mr. S. L. Worton.

Deaths.

MR. WM. ROWLANDSON, engineer, of Boundary Street, Liverpool, has died at the age of 73.

THE death is reported of Mr. G. Heward, a director of Steel & Garland, Limited, of the Priory Foundry, Worksop, at the age of 57 years.

MR. W. B. HUGHES, inventor of the Hughes stoking gas producer, and gas engineer to the Wellman-Seaver-Morgan Company, has died in the United States, at the age of 54 years.

THE death at the age of 77 is reported of Mr. Frederick Clews, a director of the firm of F. & R. Clews, Limited, brassfounders, of 104, Moland Street, and Fisher Street, Birmingham.

MR. THOS. B. SMART, whose death is reported at the age of 48, was manager to Messrs. R. Daglish & Company, Limited, the well-known St. Helens firm of engineers and iron founders.

MR. HENRY WICKS, whose death is reported to have taken place suddenly, was formerly senior partner in the well-known engineering and bridge-building firm of Burn & Company, Calcutta.

THE death has occurred at Liège, at the age of 77 years, of Prof. Victor Dwelshauvers-Dery, formerly Rector of Liège University, and a well-known Belgian authority on engineering matters.

MR. JAS. CUDWORTH, engineer and ironfounder, died recently, aged seventy years. The deceased carried on business for many years at the Eagle Foundry, Wrexham, in partnership with Mr. Wm. Johnson.

THE death is announced from Berlin of Herr Alexander Zenzes, at the age of 49 years. The deceased took an active part in the introduction of the Tropenas steel casting process and small Bessemer steel plants into Germany.

THE death has occurred of Mr. Joseph Foster, head of the firm of Joseph Foster & Sons, engineers and ironfounders, Preston. Mr. Foster, who was 83 years of age, commenced work as an apprentice, and at the age of 29 began manufacturing on his own account.

MR. JOB WHITEHOUSE, who was one of the pioneers of the edge-tool industry in Cannock, has died at the age of 86. As a young man he was closely associated with Mr. W. Gilpin, the founder of the Churchbridge Works, and, later, assisted to found the firm of Whitehouse Brothers, Bridgtown.

THE death has occurred of Mr. Alex. M. Melvin, managing director of Messrs. T. Melvin & Sons, Limited, engineers, of St. Rollox Iron Works, Glasgow. Mr. Melvin, who was born and educated in Glasgow, served his apprenticeship as an engineer, and later became associated with his father and brothers in the business.

MR. JOHN BURDON, head of the firm of John Burdon & Sons, structural engineers, Mossend, has died at the age of 73 years. The deceased began business many years ago as a general blacksmith, but subsequently branched out into the engineering trade, and having placed on the market a patent steel girder and a portable furnace, the business extended rapidly.

THE death occurred last month of Mr. William Thom, chairman of Messrs. Yates & Thom, Limited, engineers and iron founders, of Blackburn. Mr. Thom, who was 72 years of age, worked his way up from apprentice to manager of the firm, which position he held for forty years. He retired from the management in favour of his son several years ago, but still retained an interest in the business.

THE death is reported of Mr. J. Kenworthy at his residence, Prospect Cottage, Park Road, Lockwood, Huddersfield, at the age of 85. The deceased gentleman, with his brother-in-law, Mr. W. Whiteley, carried on the business of W. Whiteley & Sons, Limited, Prospect Ironworks, Lockwood. He also acquired the business of W. & C. Kaye, Lockwood Railway Wagon Works, and carried it on under the style of Jas. Kenworthy & Son.

MR. JOHN PATERSON, chairman of Murray & Paterson, Limited, engineers, Coatbridge, died at Ayr on August 23, aged 71 years. The deceased founded the engineering business of Murray & Paterson along with the late Mr. Richard Murray. He belonged to a well-

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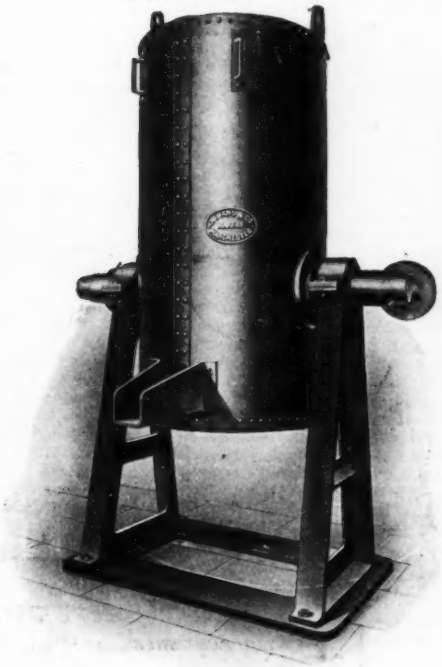

James Evans & Co.,
Britannia Works,
Blackfriars,
MANCHESTER.

Telegrams: "LADLES, MANCHESTER."

known family of landowners in Lanarkshire, Dumfriesshire, and Peeblesshire, and on succeeding to the estate of Carmacoup, near Douglas, took a less active part in business.

THE death is announced, at the age of 71, of Mr. A. A. Pope, who is well-known in the malleable-iron industry of America. Under his leadership the Cleveland Malleable Iron Company rapidly grew until it resulted finally in the malleable iron and steel casting plants of the National Malleable Castings Company, at Cleveland, Chicago, Indianapolis, Toledo, Sharon, and Melrose Park. At the time of his death, Mr. Pope was president of the National Malleable Castings Company and the Eberhard Manufacturing Company, which positions he had held since their organisation.

THE death has taken place at his residence, 11, Victoria Circus, Dowanhill, Glasgow, of Mr. T. Arrol, a director of the firm of Sir William Arrol and Company, Limited, engineers, Glasgow. Mr. Arrol, who was ill for about three weeks, was in his 51st year. He was a nephew of the late Sir William Arrol, and was connected with the firm for over 30 years. He started his apprenticeship as an engineer with Messrs. A. S. Craig and Company, Paisley. Before completing his apprenticeship, however, he went into Glasgow and entered the service of Sir William Arrol and Company, in which he remained ever after, taking a special share in the outside constructional work of the firm. Mr. Arrol was a member of Council of the Institution of Engineers and Shipbuilders in Scotland.

New Companies.

GEORGE TAYLOR (BRASS FOUNDERS), LIMITED.—Capital £10,000 in £1 shares (2,500 preference).

GODFREY MANUFACTURING COMPANY, LIMITED.—Capital £5,000 in £1 shares, to carry on the business of engineers.

WESTERN ENGINEERING COMPANY, LIMITED. Capital £2,000 in £1 shares. Registered office: 24, Frogmore Street, Bristol.

THOMAS CASH & COMPANY, LIMITED.—Capital £10,100 in £1 shares (10,000 preference), to carry on the business of ironmasters.

ALEXANDER & COMPANY (BARRHEAD), LIMITED.—Capital £5,000 in £1 shares, to carry on the business of engineers, boilermakers, electricians, etc.

THAMES SMELTING AND REFINING COMPANY, LIMITED.—Capital £15,000 in £1 shares. Registered office: Norfolk House, Norfolk Street, Strand, London, W.C.

PREMIER RANGE AND FOUNDRY COMPANY, LIMITED.—Capital £1,000 in £1 shares. Registered office: 4, Westminster Palace Gardens, Artillery Row, London, S.W.

MOSSAY & COMPANY, LIMITED.—Capital £2,000 in £1 shares, to carry on the business of engineers. Registered office: 45, Horseferry Road, Westminster, S.W.

JACKSON & OGDEN, LIMITED.—Capital £8,000 in £1 shares, to carry on the business of ironfounders. Registered office: Lansdowne Works, Ward Street, Chadderton, near Oldham.

THOMAS CROSBEE & SONS, LIMITED.—Capital £25,000 in £1 shares (7,000 preference), to take over the business of brass and nickel founders, formerly carried on as Thomas Crosbee & Sons and the Apollo Manufacturing Company, at Apollo Works, Moseley Street, Birmingham.

BAIRD BROTHERS, LIMITED.—Capital £25,000, in £1 shares (8,000 preferred), to take over the business of engineers, boiler makers, propeller makers, shipbuilders, and ship repairers and shipwrights, carried on by Messrs. T. Baird and G. Baird, at Bull Ring, North Shields, as Baird Brothers.

WEBSTER & BICKERTON & COMPANY (of Goole), LIMITED.—Capital £12,000 in £10 shares, to take over the business of engineers, ship repairers, boiler and engine makers, and iron and brass founders, carried on by Messrs. G. Webster and R. G. Bickerton, at Goole, as Webster and Bickerton.

MOSTON MALLEABLE CASTINGS COMPANY, LIMITED.—Capital £6,000 in £1 shares, to take over the business of an iron and steel founder carried on by Tom Parkin at St. Mary's Road, Newton Heath, Manchester, as the Moston Malleable Castings Company. Registered office: St. Mary's Road, Moston, Manchester.

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PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years:—

Metals.	End Aug., 1913.	End Aug., 1912.
Iron—Scotch pig warrants ton	*62/-	*69/3
—Middlesbro' warrants ton	55 0	63 8
—W.C. Mines Bessemer ... ton	67 6	79 6
—Stock, Middlesbrough ... tons	187,796	90,648
Copper—Chili bars GMB ton	£71 0 0	£78 18 9
—Stock, Europe and afloat tons	34,045	50,332
Tin—English ingots ... ton	£201 10 0	£214 10 0
—Straits ... ... ton	£197 5 0	£212 0 0
—Stock, London, Holland, U.S.A., and afloat ...tons	12,841	12,213
Lead—English pig ... ton	£20 15 0	£21 0 0
Spelter—Ord. Silesian ... ton	£21 12 6	£26 10 0
Quicksilver (75lb)... bottle	£7 5 0	£7 15 0
Antimony—Regulus ... ton	£28 10 0 £31 10 0	£28 0 0 £29 0 0
Aluminium—Ingot ... ton	£86 0 0 £88 0 0	£80 0 0

*Settlement price.

Castings.

In the Cleveland district the following are the nominal rates current for castings:—

	£ s. d.		£ s. d.
Columns (plain)	7 7 6	to	7 12 6
Pipes, 1¼ to 2½ in.	6 12 6	to	7 0 0
,, 3 to 4 in.	6 5 0	to	6 7 6
,, 5 to 8 in.	6 0 0	to	6 2 6
,, 10 to 16 in.	6 2 6	to	—
,, 18 to 24 in.	6 2 6	to	—
Chairs	4 14 0	to	4 15 0
Floor plates (open sand)	3 10 0	to	3 12 6

Scrap.

The quotations for scrap, subject to market fluctuations, are as follows: Heavy wrought (mixed), £2 17s. 6d.; light wrought, £1 5s. 0d.; heavy cast, £3 3s. 6d.; all per ton, f.o.b., London. Copper (clean), £64 10s. 0d.; brass (clean), £44 0s. 0d.; lead (usual draft), £19 0s. 0d.; Zinc, £16 5s. 0d.; all per ton delivered merchant's yards.

Legal.

Trade Marks Appeal.

Judgment has been delivered in the Court of Appeal in the action of John H. Andrew & Company, Limited, of the Toledo Steel Works, Sheffield, *v.* Kuehnrich, the latter (the defendant) appealing from a decision of Lord Justice Swinfen Eady. It was alleged by the plaintiffs that defendant, trading as Darwin & Milner at Sheffield, had infringed four marks belonging to them.

Lord Justice Vaughan Williams, giving judgment, said he did not think that the evidence supported Lord Justice Swinfen Eady's view as to dishonesty on the part of the defendant. There was no evidence that the defendant had such knowledge of the plaintiff's marks as to justify the conclusion that he was imitating those marks. In fact, the defendant's mark was contained in a device, and was applied to such goods as to make the suggestion of imitation positively absurd. He thought that the argument of Mr. Walter, K.C., as to the registration by the plaintiffs of their new "A B C" mark was sound, and that the Cutlers' Company ought not to have allowed registration of plaintiffs' new mark.

The Court accordingly allowed the appeal in the action, and dismissed the action with costs, including the costs of this appeal;

Allowed the appeal in the matter of the application to the Cutlers' Company, the plaintiffs to pay the costs of that application here and below;

Allowed the appeal as to plaintiffs' mark "C," and directed that that mark should be expunged from the register; and

As to plaintiffs' trade mark "A" and "B" and "A B," dismissed the appeal, there to be no costs here or below as regarded defendant's application to take plaintiffs' marks off the register.

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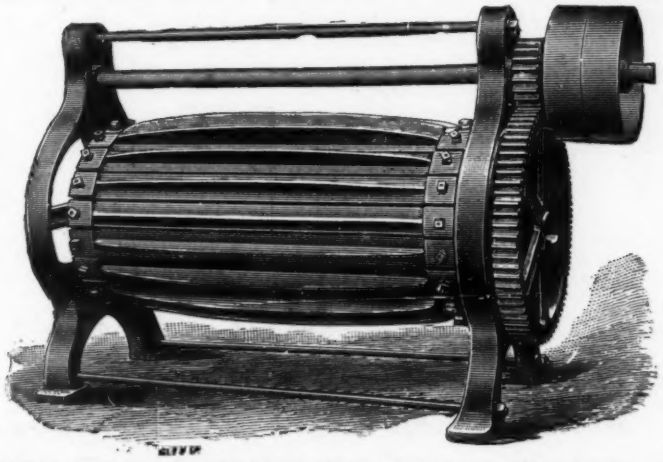

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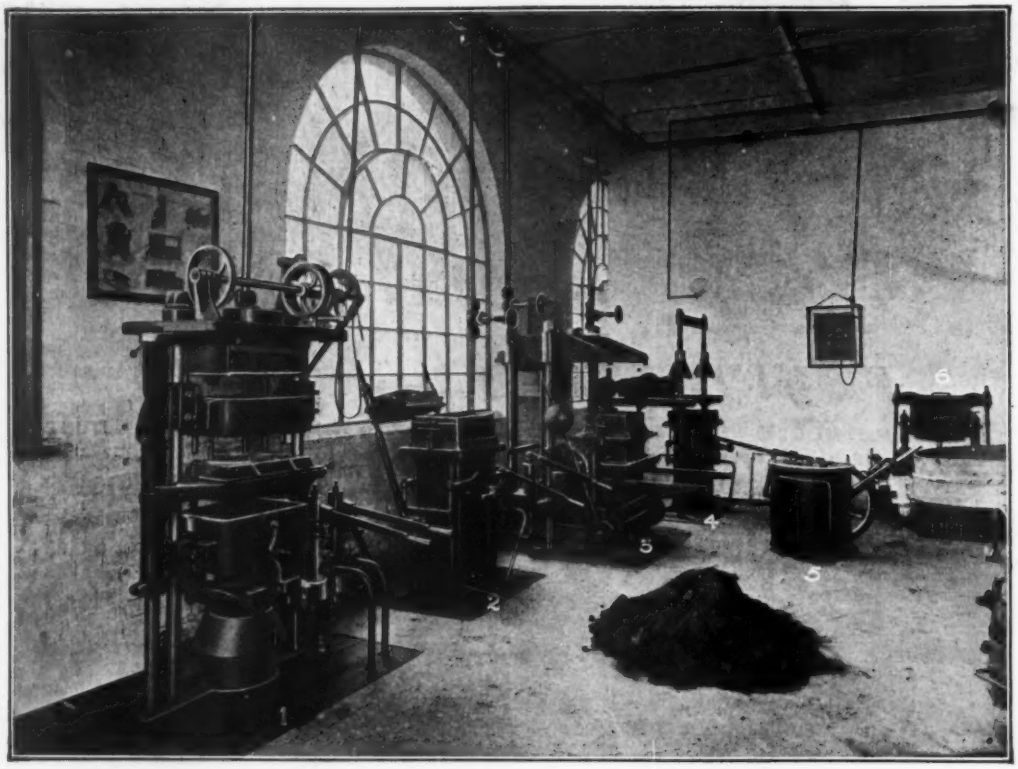

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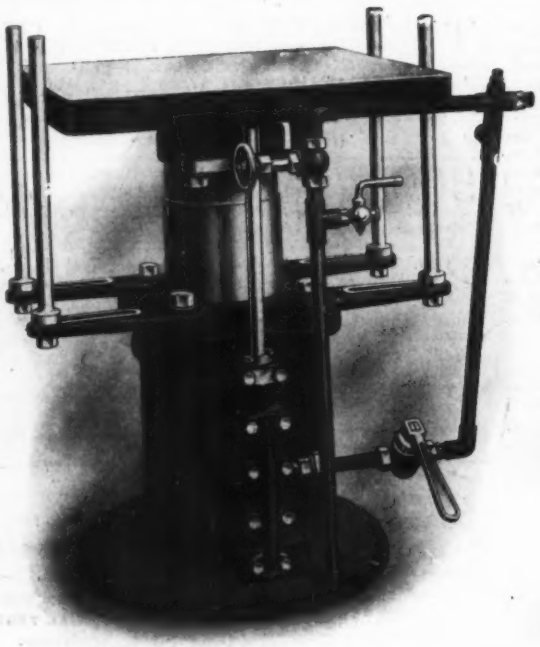

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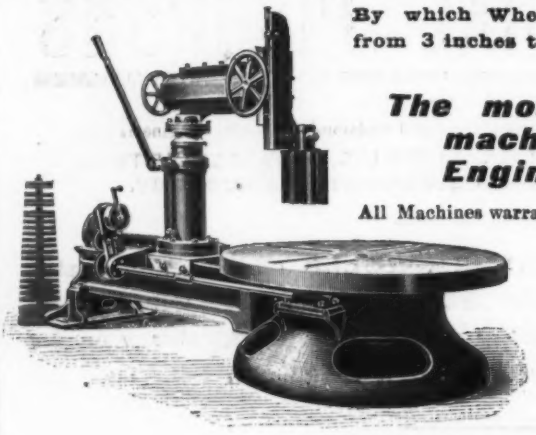

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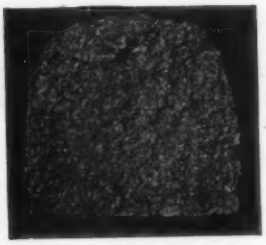

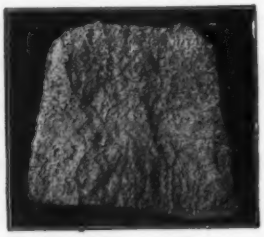

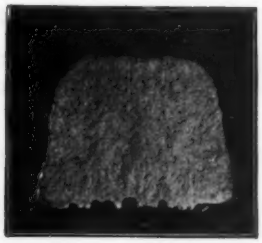

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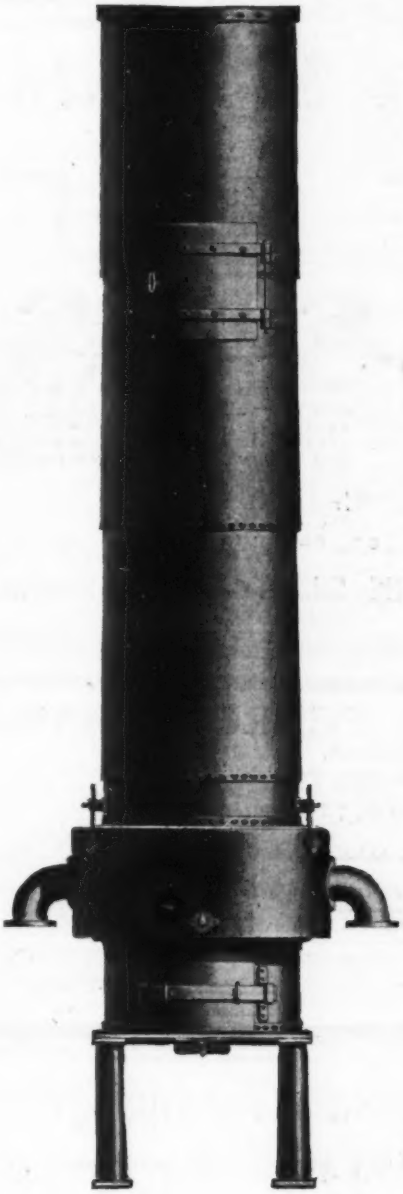

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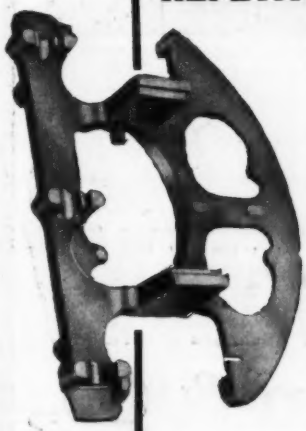

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PATENT UNBREAKABLE
STEEL LADLES
These Ladles are manufactured by a patented process, each from a single steel plate without weld or rivet. They are extremely light, being at the same time the strongest and most durable in the market. Ladles to contain 56 lb. of metal only weigh about 7 lb. each. They are made of all capacities from 30 lb. to 60 cwt., with or without lips; also mounted or unmounted. They are also suitable for chemical and metallurgical processes. List of sections and prices on application to
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KINNING PARK IRONWORKS,
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36"
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Can also be made in Aluminium.

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All kinds of Letters for Pattern-making and Foundries supplied from stock at very advantageous prices.

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BARGAINS FOR PROMPT CASH.

No. – Root's Blower "Acme" for 20 smiths' fires.
One ditto, with high-speed Vertical Engine combined.
Thwaites Roots Blower, 11¼" discharge.
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Foundry Blowing Fan, 36" impeller, 19" discharge, also 9¾" round outlet to fit on same.
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FERRO-VANADIUM. * * * FERRO-TITANIUM.

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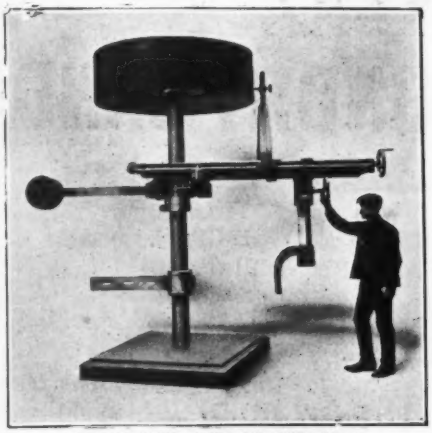

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ALL IRON AND STEEL FOUNDRIES

SHOULD BE EQUIPPED WITH

STEWART WHEEL MOULDING MACHINES.

Complete Satisfaction Guaranteed

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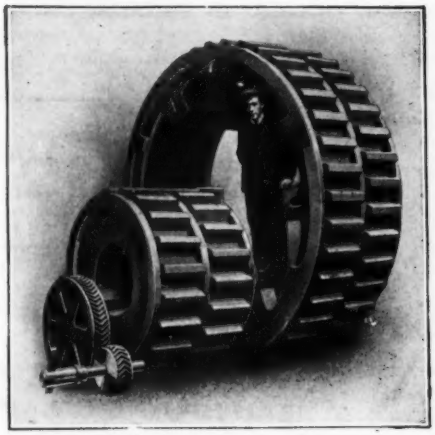

Wheels Moulded by this Machine.

No Loose Parts Liable to be Lost.

ACCURATE. PORTABLE. CHEAP.

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WE SUPPLY THE LEADING FIRMS IN THE TRADE WITH

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KINDLY HAND US YOUR ENQUIRIES.

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Saves about 80 per cent. in the Sand Account.

TURNS OUT BETTER AND SOUNDER CASTINGS, WITH A BEAUTIFUL SKIN. NO OLD SAND TO CART AWAY.

If you have a Foundry, this is of importance to you

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Money is being wasted in costly experiments in hundreds of English foundries in an attempt to make good Semi-Steel.

Cupolas are being turned into test tubes. The foundry has become a laboratory. But no laboratory ever showed a profit—only an expense.

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They figure that within a short time their practice will be so greatly improved over that followed in other English foundries that they will be able to outstrip all competitors both in price and quality of work.

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Please send 32-page booklet "Semi-Steel" and full information free.

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THE "LEEDS" DEAD LENGTH CORE MACHINE.

Makes Cores from ⅛ in. to 6 in. dia.

Ordinary Core Sand is used, without any special ingredients, and cores are made to an exact finished length.

A great labour-saver and invaluable in any Foundry.

We also supply:

CUPOLAS,
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SAND MIXERS,
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BEST QUALITY.

LESSEES OF DELPH AND TINTERN ABBEY BLACK AND WHITE CLAY.

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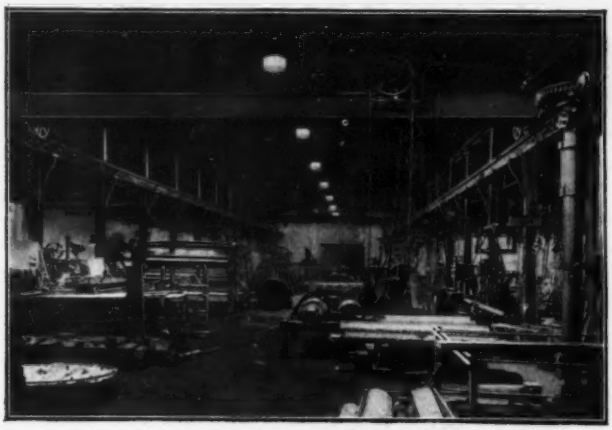

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THE KEITH LIGHT

Efficient lighting in the Foundry reduces the likelihood of faulty work, and other risks incidental to poor lighting.

The Keith System of High Pressure Gas Lighting is *very economical*, and gives a white light of high candle power and well diffused. quality, which does not fatigue the eyes of the workers.

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MOULD DRYING LAMP

For Skin Drying Loam and Green Sand Moulds, Lighting Cupolas and General Illuminating purposes. Burns common Paraffin, one Gallon will last about 2½ hours under continuous working.

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WE CAN SUPPLY YOU AT COMPETITIVE PRICES WITH BETTER PLANT AND REQUISITES THAN YOU BUY ELSEWHERE.

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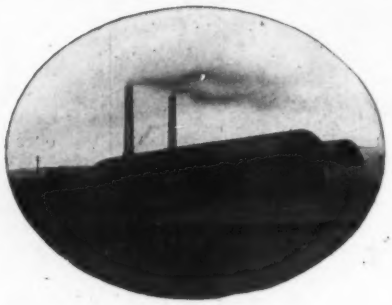

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It is now used all over the World for all kinds of Heavy and Light Engineering Work, including Hematite and Special Iron Castings; also for Agricultural Implements, Stove Work, Baths, &c.

It has, in dozens of cases, given better results than the best Plumbago at three times the price.

We can deliver it to most Foundry Centres and Ports at

£5 PER TON.

2 ton lots and upwards, in Bags; extra for Casks and Special Packing. Smaller lots 6s. per cwt.

TRIAL LOT DELIVERED FREE TO ANY GOOD BUYER.

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FOUNDRY PLANT.

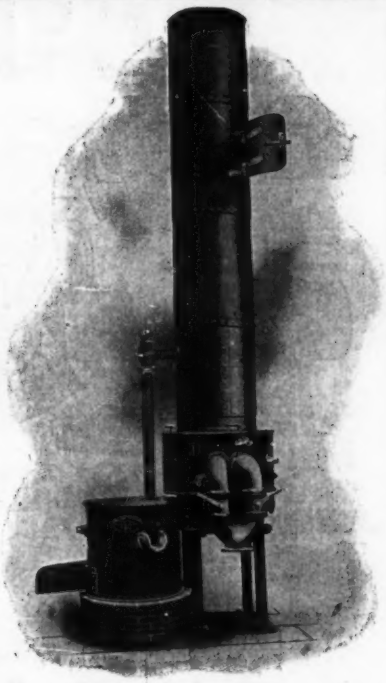
"Rapid" Cupolas,

with or without receivers or drop bottoms.

Roots' Blowers,

belt, steam-engine, or electro-motor driven.

Charging Platforms, Hoists, and Ladles.



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We are the original makers of "Rapid" Cupolas as under Stewart's Patent. We make this intimation as other makers are introducing this description, which had become established as a synonym of Stewart's Cupolas.

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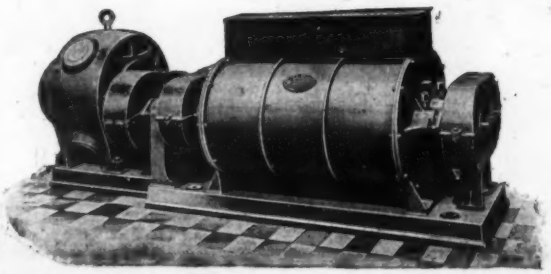

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